Joint Military Utility Assessment for the CINC 21 Advanced Concept Technology Demonstration

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ADMINISTRATIVE INFORMATION

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Appreciation for a job well done is extended to everyone.

Executive Summary

The Commander in Chief 21st Century (CINC 21) is an Advanced Concept Technology Demonstration (ACTD) that was designed to improve command and control and decision-making through network-centric, knowledge-enabled staff functions. CINC 21's goal is to improve command and control of forces by exploiting advanced visualization techniques and decision support systems (e.g., presentations, cueing, triggers, alerts), collaboration capabilities, and knowledge and enterprise management technologies. CINC 21 used information technology to reduce dependence on centralized, single-crisis command centers in favor of decentralized, rapidly configured coalition and interagency enclaves.

To evaluate the technologies developed as part of the CINC 21 ACTD, a Joint Military Utility Assessment (JMUA) was planned and executed. The purpose of the JMUA was to determine how well the CINC 21 products met warfighter requirements.

What is CINC 21?

The vision of CINC 21 is to develop and assess a decision-focused command and control framework that enables joint commands to dynamically manage and focus organization, processes, resources, and information to improve situational awareness and decision-making. CINC 21 comprises: an advanced concept of a synchronized battle rhythm and an enterprise architecture, an integrating framework for decision-focused command and control, a set of integrating services; a set of applications (operational packages), command and control infrastructure services, hardware displays, computer hardware, and security systems.

Why Develop CINC 21?

The operational concept for CINC 21 is a knowledge-enabled information sphere with tools and applications to (1) improve situational awareness and understanding, (2) facilitate the ability to collaborate when necessary, and (3) manage the information enterprise, while transforming and accelerating the decision processes that underlay the management of crisis-contingency operations, theater engagement, and staff processes. The critical operational issues (COIs) for CINC 21 were:

- Can advanced visualization technology empower individuals to process, digest, and assimilate large volumes of information, enabling faster, more effective decisions?
- Can knowledge management technology integrate information, context, and rules to increase understanding and improve decision-making?
- Can collaboration tools be used to overcome tyrannies of time, distance, and system disparity?
- Can the collection of networks, databases, and applications be enhanced to optimize the flow of information, with security assurance, across multiple network enclaves?

Who Had Assessment Responsibility?

The principal organizations that executed CINC 21 were the Deputy Under Secretary of Defense (DUSD) Advanced Systems & Concepts (AS&C), United States Pacific Command (USPACOM), U.S. Strategic Command (USSTRATCOM), the Office of Naval Research (ONR), the Defense Information Systems Agency (DISA), Space and Naval Warfare Systems Command (SPAWAR), DUSD (Science & Technology), the Defense Intelligence Agency (DIA), and the Defense Threat Reduction Agency (DTRA). USPACOM was the sponsoring Combat Commander (COCOM) and was the Operational Manager for the Advanced Concept Technology Demonstration (ACTD). The Office of Naval Research (ONR) and Defense Information Systems Agency (DISA) shared responsibilities of Technical Manager. SPAWAR acted as the Transition Manager for the CINC 21 ACTD. USPACCOM and United States Strategic Command (USSTRATCOM) provided the operational settings for the ACTD.

How Was CINC 21 Assessed?

Based on the COIs and prioritized requirements, a Joint Military Utility Assessment (JMUA; Appendix B) plan was developed to evaluate CINC 21 capabilities for acquiring, processing, analyzing, and presenting information needed for better decision making, improved processes, increased overall readiness, efficiency, and mission effectiveness. Measures of effectiveness (MOEs) were defined along with subsequent measures of performance (MOPs) and metrics to assess the CINC 21 products in an operational setting and ensure validity of measurement. These measures and metrics were organized by three mission effectiveness criteria: Suitability, Usability, and Technical.

CINC 21 assessment efforts were conducted throughout the technology development and integration period. Consequently, different sets of assessment methods and metrics from the JMUA Plan were used as appropriate for the technology type, development maturity, and assessment environment. Trouble reports and technical observations/logs were analyzed to identify successes and problems associated with the installation and integration of the diverse set of CINC 21 products. The usability of CINC 21 products was assessed by several methods: (1) heuristic evaluations that compared the user interface against industry standards and guidelines, (2) informal comments and observations by representative users, and (3) structured ratings and performance tests of the user interface under scenario-based task conditions. The impact of CINC 21 products on organizational effectiveness and work processes was assessed in similar ways. The suitability of CINC 21 technology to support operational tasks was assessed via direct involvement by representative operational decision-makers and staff. They provided comments and ratings on the technology during several demonstrations and training sessions, and they used the technology for their dynamic tasks in large-scale exercises.

Outcome

The composite ratings for Suitability, Usability, and Technical for each of the CINC 21 technology categories are summarized below in the table and accompanying text. The technology category ratings are given for the COIs that are applicable. In cases where a technology category applies to more than one COI, different aspects were evaluated. For example, Decision-Focused Command and Control (DFC2) involves the presentation of information (COI-1) and the organization and management of that information in a common knowledge core (COI-2).

Decision-Focused Command and Control (DFC2)

The *concept* of DFC2—integrated applications that facilitate the definition, visualization, analysis, and management of decision-making activities associated with joint command and control—was well received by users. However, there is currently a lack of functioning links between component parts and between decision objects within component parts. The document linking and management services in their current stage of development do not fulfill users' needs. In addition, concerns regarding the impact of DFC2 upon workload and organizational procedures remain. Usability problems were experienced throughout the assessment events, especially in areas of configuration retention and navigation. Excessive use of scrollbars limit users' ability to maneuver, and they present a confusing display. Many functions require numerous steps as well as interaction with multiple dialog boxes. The use of screen real estate is less than optimal; web parts are located partially or completely off the screen. A slow refresh rate and some instability of component parts occurred throughout the assessment events. These problems interfered with users as they attempted to enter or access information. There were intermittent crashes of DFC2 during TF03; these crashes were associated with data losses.

Operational Packages

The Operational Packages are applications that use the underlying enterprise architecture to provide new production capabilities for staff and subordinate commands. These applications provided information that is stored in databases and is then available as supporting content that can be aggregated/rolled up for the decision-maker. The following sections describe the operational packages.

Common Operational Picture/Geo-Spatial Visualization

The Area of Responsibility Basing (AORB) and Fused Battlespace View (FBV) tools helped users perform their assigned tasks and achieve their operational goals. Users appreciated the concept of the geo-spatial representation, in which they could drill down and gather their desired content. Users successfully navigated with the tools and reached their target information. The technical implementation of these tools was less than satisfactory, however. AORB was in an early stage of development and the databases needed to support its capability were not available. FBV did not yet include classified information, which users said was needed for it to be of real value.

Technology Category	COI-1			COI-2			COI-3			COI-4		
	S	U	T	S	U	T	S	U	T	S	U	T
Decision-Focused C2	Y	Y	Y	Y	Y	Y	NA	NA	NA	NA	NA	NA
Ops Package: COP/Geo-Spatial Visualization	G	G	Y	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ops Package: Briefing/ Information Summary	G	G	G	G	G	Y	NA	NA	NA	NA	NA	NA
Ops Package: Status Tracking and Linking	G	Y	G	Y	Y	Y	NA	NA	NA	NA	NA	NA
Ops Package: Time-Based Event Management	G	G	G	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ops Package: JWID Coalition Interoperability Service (COINS)	NA	NA	NA	G	Y	G	NA	NA	NA	NA	NA	NA
Displays: Group Displays	G	G	G	NA	NA	NA	NA	NA	NA	NA	NA	NA
Displays: Workstation Displays	G	G	G	NA	NA	NA	NA	NA	NA	NA	NA	NA
Collaboration	NA	NA	NA	NA	NA	NA	G	Y	Y	NA	NA	NA
Network Operations Tools and Services	NA	NA	NA	NA	NA	NA	NA	NA	NA	G	Y	Y

Note: S = Suitability, U = Usability, and T = Technical.

Note: G = GREEN, Y = YELLOW, and R = RED.

Briefing/Information Summary

The COA Matrix and Consequence Management Automated Brief tools appear to meet their operational requirements. There are, however, many usability issues that should be improved. The usability of the COA Matrix was well received by the operators. The usability problems with Consequence Management should be addressed before further development.

Status Tracking and Linking

The Message Tracker is effective at linking messages to significant events and increasing staff's access to information. Improving its interface features, error prevention and detection, online help, and searching will enhance its usability. However, none of these shortcomings prevent users from accomplishing their tasks. The RFI Manager had significant problems with Usability and Suitability and will require redesign to become an effective tool. Aside from slow response times in some circumstances, TeamApp performs its functions well. It simplifies the insertion of documents into Web pages, facilitates staff interaction, and may also reduce manpower requirements.

Time-Based Event Management

While there is room for improvement in addressing the needs of individual users, the Master Calendar and the Task Management System (TMS) generally meet the needs of their users. They have been accepted by the users and are currently being used at USPACOM.

JWID Coalition Interoperability Service (COINS)

JWID COINS was judged to provide capabilities of value for integrating information, context, and rules to increase understanding and improve decision-making. The ease of use and display issues with this technology are problematic and may affect user acceptance. Problems noted with the human–computer interface design for data entry, displayed results, and multi-step processes need to be resolved. Further development effort is needed to provide a satisfactory refresh rate and to provide the ability to save inputs.

Displays

Group Displays

The USSTRATCOM Knowledge Wall and the USPACOM Video Wall are currently in use, function reliably, and generally meet the needs of their users. The USSTRATCOM Knowledge Wall effectively met the needs of the senior decision-makers during the October 2002 demonstration. Knowledge Wall operators were able to manipulate content and present it in a way that was relevant and legible. There are some unresolved issues regarding the military utility of the Video Wall. The success of the Knowledge Wall, though, outweigh the inadequacies found on the Video Wall, which is not making the transfer to the new command center.

Workstation Displays

The Workstation Displays, consisting of multiple side-by-side monitors and a single multi-panel display console (PV290), were well received by users. The PV290 performed without incident during the USSTRATCOM October 2002 demonstration. During TF03 at USPACOM, users reported their three-screen flat-panel display workstation was essential in providing users a continuous view of the various web parts. This view increased the usability of the displays and

helped meet their operational requirements. However, the workstation was effective only in presenting content to the user sitting directly in front of the screens and not to others standing around the display.

Collaboration

Distributed users found high value in sharing documents, briefs, and desktops. They considered that collaboration tools increased situation awareness by providing an efficient mechanism for the exchange of information. However, the inability of CINC 21 collaborative services to provide stable connectivity is a major obstacle toward reaching the goal of synchronizing decision-making and information management among distributed users. Other impediments to use are lack of training, lack of business rules, and lack of interoperability between collaboration systems. Chat often became the de facto collaboration tool due to bandwidth restrictions. Audio was preferred when available; video was often unstable and considered by many users to be redundant and unnecessary. The status of audio-video and of session membership was frequently difficult to discern. In addition, feedback to the user regarding success of data transmittals was not always adequate.

Network Operations Tools and Services

Many network operations tools and services were implemented. These tools give the network managers the ability to interact with other management tools. The portal approach resulted in flexibility of display and screen space usage. The users found the Theater C4ISR Status Grid to be useful for such tasks as changing layout and exchanging information. However, workload was not decreased, and learning how to use the capability was difficult. Transmitted information did not increase the ability to view and monitor network operations. Some of the data visualization tools need improvement for easier comprehension.

All the Network Operations tools are scheduled for transition to DFC2, which will be implemented in the DISA Network Centric Enterprise Services (NCES)/Joint Command and Control (JC2) efforts. The NetOps Network Status Monitoring will transition to the USPACOM Theater C4I Coordination Center. The Advanced Intrusion Detection Events (AIDE) system visualizations (Events Involving Critical Servers [EICS], Event Priority Chart [EPC], and Link Analysis tools) will transition to the DISA Information Superiority Situational Awareness (ISSA) Portal initiative.

So What?

Assessments for COIs

The overall assessments of Suitability, Usability, and Technical for each COI are shown in the following table. The CINC 21 products that contribute to COI-1 were generally considered to help decision-makers and staff to process, digest, and assimilate large amounts of complex information. Most of these products were useful for the operational tasks and work processes, and they were relatively easy to use. Suitability and Usability are rated as GREEN for the

combination of products related to COI-1. The overall rating for COI-1 for Technical is YELLOW because many of the products were not yet developed to the point where they could reliably provide dynamic, real-world data to users. Overall, the Suitability and Usability COI-1 objectives are being met, but there are concerns with the DFC2 that should be addressed. There are still issues to be resolved regarding how best to integrate all the relevant information and present it in a useful manner.

Critical Operational Issue	Suitability	Usability	Technical
1 – Decision-Focused Visualization	G	G	Y
2 – Knowledge Management	Y	Y	Y
3 – Collaboration	G	Y	Y
4 – Enterprise Awareness & Network Security	G	Y	Y

The CINC 21 products and concepts provided many exciting and innovative approaches to knowledge management. The current versions of the products, however, need further refinement to achieve these goals to the levels needed by operational users. For COI-2, Suitability, Usability, and Technical ratings were all YELLOW. Suitability can be improved by linking more of the key data sources together. Usability can be improved by making it easier for operational users to ingest and link messages and other data together. Many technical challenges remain to be resolved concerning how to enable CINC 21 products to deliver the range of operational content that users need in an accurate and reliable manner.

As called for in COI-3, collaboration technology is an important capability that can enhance distributed decision-making substantially. Users consistently reinforced this, reporting that the CINC 21 collaboration products were very useful for their operational needs. Suitability, was, therefore, rated as GREEN. Some of the collaboration products were difficult to configure and to use, however. This difficulty accounts for the YELLOW rating for Usability. The biggest obstacle for collaboration technology was clearly the technical issues; Technical was also rated as YELLOW. The products were often incompatible with each other, required excessive bandwidth, and operated unreliably.

COI-4 calls for advances in the secure exchange of information across multiple, distributed networks, databases, and applications. Given successes with the CINC 21 products developed to satisfy COI-4, the Network Operations tool suite will be featured in next-generation implementations. Suitability for COI-4 was rated as GREEN. There were some operational and integration issues, however, with information assurance tools that impede achievement of all requirements. Ratings for Usability and Technical were YELLOW.

Transition

Many varied types of technical products were developed as part of the CINC 21 program. While some applications directly support users' work processes and tasks, others involve system architecture concepts and enterprise infrastructure that enable other products to function effectively. Some products explore the feasibility of potentially relevant techniques, and other interim products were abandoned as the focus changed due to external factors, like Navy Marine Corps Internet (NMCI).

CINC 21 products that are candidates for transition were identified, based on their Suitability, Usability, and Technical assessments. These transition products include the following :

- TeamApp
- Task Management System
- Master Calendar
- Fused Battlespace View
- Request for Information (RFI) Manager
- Network Operational Tools and Services
- Visualization (Displays)
- Message Tracker
- DFC2
- Collaboration

Specific enhancements are recommended that are intended to help these products achieve an acceptable level of performance in an operational setting. Transition priorities and an implementation timeline were determined by the amount of effort estimated to be required to make the recommended enhancements.

The CINC 21 products that have been identified for transition need to be incorporated into a feasible standard operating procedure (SOP) that includes defined staff roles and work processes. While substantial variations in the details of the SOP are expected across COCOMs because of their unique responsibilities and operating areas, there should be a common framework. The CINC 21 operating concepts and system architecture enable the products to be used in a common manner that generalizes to many different environments, including COCOMs and Joint Task Forces (JTFs).

Various enhancements will need to be made to the CINC 21 products to make them more suitable, usable, and technically sound in operational settings. Several specific suggestions for these enhancements have been provided for CINC 21 products in this report and in previous assessment reports. Operational users should have periodic opportunities to review the technical modifications and to provide feedback on the enhancements.

Once the product enhancements have been made and reviewed by representative operational users, a variety of supporting documentation will need to be prepared. This documentation includes training materials, system support and administration procedures, and similar reference materials.

Finally, the enhanced product capabilities should be assessed in a realistic operational context. This assessment is not focused on determining military utility but rather on verifying that the product enhancements function properly and satisfy user needs and system requirements.

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Advanced Concept Technology Demonstration

Introduction

Background

Theater Combatant Commanders (COCOMs) are actively engaged in world events across the spectrum of operations. Operational crises often involve other nations, peer agencies, and/or non-government organization (NGO) partners. COCOMs must improve the functionality of these complex relationships. COCOMs operate in an information environment where they and their staffs are simultaneously overwhelmed with information and left starved for knowledge.

Once data are available, humans manually cull through the information to determine relevance to a problem at hand. To be used optimally, information must be organized around mission areas, foundation and functional areas, tasks, and processes. Information must then be managed to ensure consistency and shared with distributed sites. Dispersing the information across multiple sources, security levels, and networks increases the complexity of sharing and using the information.

Joint Vision 2020 (JV2020)[1] builds upon and extends the conceptual template established by Joint Vision 2010 to guide the transformation of America's Armed Forces (Joint Staff, 2002). The overall goal of the transformation is the creation of a force that is dominant across the full spectrum of military operations—much of it never experienced before. This world will be an information-dependent, information-saturated world, and a much less predictable world than the one known before. Our advantage must come from information superiority and innovations that enable us to take advantage of technology to achieve superior warfighting effectiveness.

As the military moves toward JV2020 solutions, COCOMs are challenged by intricate information and force structure relationships. Information superiority will be increasingly essential to successful operations in the 21st Century. However, we need more than information superiority; we must achieve decision superiority, which is the ability to effectively use and quickly exploit information. Forces and decision-makers will be distributed, but must function as one cohesive team.

[1] Joint Chiefs of Staff. 2000. *Joint Vision 2020*. Department of Defense, Washington, DC.

As the military moves toward JV2020 solutions, COCOMs are challenged by intricate information and force structure relationships. Information superiority will be increasingly essential to successful operations in the 21st Century. However, we need more than information superiority; we must achieve decision superiority, which is the ability to effectively use and quickly exploit information. Forces and decision-makers will be distributed, but must function as one cohesive team.

The United States Pacific Command (USPACOM) has initiated the Theater Plan for Transformation. The Theater Plan for Transformation provides the guidance for developing an information infrastructure to enhance mission effectiveness and improve situational awareness. The USPACOM Chief Information Officer has defined the Information Capabilities Framework (ICF) for developing an effective information management infrastructure. Figure 1 illustrates a high-level view of the ICF with one layer expanded to highlight how users interface with the information infrastructure through common, operational, and operational support applications.

The knowledge presentation framework (Figure 2) provides the structure for capturing information sets, rules, and situation awareness within contexts and making it all available to others. The basic element for connecting together all parts is the “view.” A view is the product of information producers to provide to decision-makers via the network. In its most complex form, a view is a template that is connected to information elements using Extensible Markup Language (XML). In this case, the view assembles information elements using XML Extensible Stylesheet Language (XSL). In its most simple form, a view can be a simple page of information, a briefing slide, a video feed, a picture, an image or a combination of all. A key point is that views show “live” information, not simply static pictures or pages. Information or sensor feeds (including video) are updated in the information base and therefore are automatically updated in the view because they are linked via XML tags. To create views, Knowledge View Control tools are used to assemble information elements and objects into templates, pages, and windows. Once a knowledge worker or subject matter expert creates a view, he stores it into a Knowledge View Library. Any other knowledge worker or decision-maker can then find and select views that are needed to insert into “cells.” Multiple cells are then arranged in a “decision support workspace.” “Frames” bound the cells of a decision support workspace,” and these frames can be moved to resize and reposition the cells into the desired configuration. Decision support workspaces can then be used for status boards, large screen displays, and fixed windows to support a collaboration session with a combination of a chat window, video window, common operational picture, whiteboard, and the like. Like views, decision-support workspaces can be stored in a library for other knowledge workers and decision-makers to use as well. A knowledge core links the knowledge views, decision support workspace tools, office automation tools, and standard query and report tools to the information base. The knowledge core comprises the protocols, formats, rules, discipline and framework needed to link information with experts and users to knowledge products. The knowledge presentation framework links external information and knowledge sources with a command’s internal information sets. As improvements in the information technology migrate into the Department of Defense, USPACOM, and other Combatant Commanders can readily adapt their organizations to provide more effective command and control planning and decision-making.

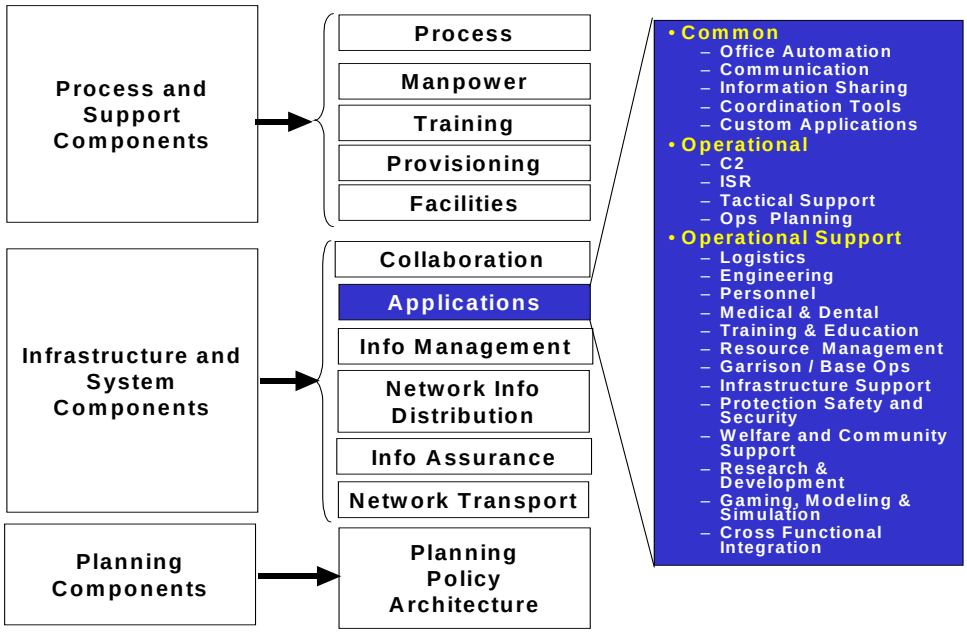

Figure 1. ICF high-level organization.

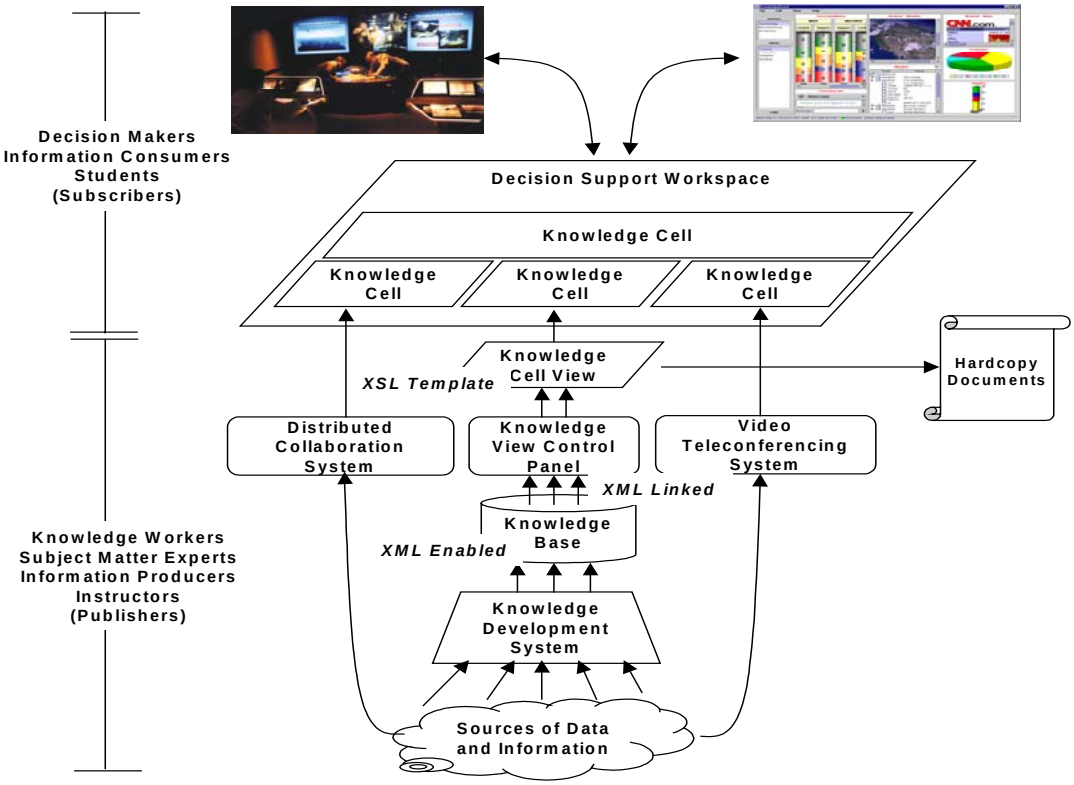

Figure 2. Knowledge presentation framework.

Goal of the CINC 21 Advanced Concept Technology Demonstration

The Commander in Chief 21st Century (CINC 21) is an Advanced Concept Technology Demonstration (ACTD) that was designed to provide broad solutions to these problems. CINC 21's goal is to improve command and control of forces by exploiting advanced visualization techniques and decision support systems (e.g., presentations, cueing, triggers, alerts), collaboration capabilities, and knowledge and enterprise management technologies. CINC 21 used information technology to reduce dependence on centralized, single-crisis command centers in favor of decentralized, rapidly configured coalition and interagency enclaves.

Purpose of the Joint Military Utility Assessment

To evaluate the technologies developed as part of the CINC 21 ACTD, a Joint Military Utility Assessment (JMUA) was planned and executed. The purpose of the JMUA was to determine how well the CINC 21 products met warfighter requirements. The general approach for the JMUA involved several phases—some analytic and others empirical. In this way, the most complete technology assessment would be conducted in an efficient manner that is minimally intrusive on any exercises or other events in which CINC 21 was being demonstrated/evaluated.

Organization of this Report

This report is organized according to the following sections:

- **WHAT IS CINC 21?**
  - an overview of the ACTD and the products
- **WHY DEVELOP CINC 21?**
  - a description of the operational issues and requirements
- **WHO HAD ASSESSMENT RESPONSIBILITY?**
  - the roles and responsibilities of the assessment team
- **HOW WAS CINC 21 ASSESSED?**
  - the approach and assessment criteria used for the JMUA
- **OUTCOME**
  - the detailed analysis of the results
- **SO WHAT?**
  - a list of conclusions, recommendations, and a plan for transition

What is CINC 21?

Overview

During crises, the flood of data that becomes available is such that accessing information, placing it in context, and understanding its relevance is extremely difficult. When faced with multiple crises in the theater, the deluge of information is even greater. Today's battle staffs are constrained by limited command center spaces, lack of intelligent display systems, and organizationally limited information flow. To complicate the problem, networks that are located away from major headquarters elements are severely restricted in capacity. CINC 21's goal was to improve command and control of forces by exploiting advanced visualization techniques and decision support systems (e.g., presentations, cueing, triggers, alerts), collaboration capabilities, and knowledge and enterprise management technologies. CINC 21 used information technology to reduce dependence on centralized, single-crisis command centers in favor of decentralized, rapidly configured coalition and interagency enclaves.

CINC 21 focused on accelerating the ability of decision-makers to understand the impact of events and to improve their ability to collaborate, plan, and make decisions on appropriate courses of action in situations involving multiple concurrent theater operations and coalition activities. The ACTD is a 5-year effort that continues through Fiscal Year (FY) 2004. CINC 21 also addressed the problems associated with the need to collaborate, plan, and decide with all essential parties regarding appropriate courses of action in situations involving multiple, concurrent theater operations and coalition activities.

The major objectives of CINC 21 are as follows:

1. Improve situational awareness and understanding by means of (a) shared understanding of operational situation, (b) ability to scale and tailor visualization, and (c) advanced decision support and knowledge management tools.
2. Demonstrate and synchronize distributed decision-making, collaboration, and information management/information dissemination tools among joint, coalition, inter-agency, and non-governmental organization (NGO) partners.
3. Enable command of the information enterprise via advanced enterprise management tools and user-specified and prioritized operational products.

Products

The vision of CINC 21 is to develop and assess a decision-focused command and control framework that enables joint commands to dynamically manage and focus organization, processes, resources, and information to improve situational awareness and decision-making. CINC 21 comprises:

- A Set of Concepts
- An Enterprise Command and Control Infrastructure
- Decision-Focused Command and Control Applications
- Operational Packages
- Displays
- A Collaboration Capability
- Network Operations Tools and Services
- Special Projects

Concepts

The advanced concept is intellectual property associated with a change in business process. It provides shared views across the enterprise to facilitate a common understanding of the situation and the decision environment. The views allow the command to dynamically manage and focus across the immediate command and desired supporting commands. The functional capability is a shared set of views across the enterprise to facilitate a common understanding of the situation and the decision environment. The views allow the command to dynamically manage decisions and focus across the immediate command and desired supporting commands. This common understanding can be achieved in a command center, in an office, and even on a laptop in transit simultaneously. CINC 21 defined four concepts.

Enterprise Architecture

The Enterprise Architecture is the underlying assembly of technologies of hardware and software components necessary to support the battle rhythm concept. These technologies provide a three-tier architecture that cleanly separates data from business logic from presentation. It provides knowledge management based on metadata (XML). It highlights the use of web services and databases to provide heterogeneous information access across the enterprise. This access allows dynamic content sharing and dynamic views to create knowledge and support decision-making using various display media.

Optimal Knowledge Wall Usage

The Knowledge Wall is a high-resolution group display that is intended to promote shared visualization and shared situation awareness among co-located, functionally distinct teams. The optimal usage of this group display technology is a concept that involves business processes, display layout, and decision space management for configuring large volumes of information in useful and usable ways. An optimally configured knowledge wall promotes collaboration and information exchange among team members and facilitates the function-specific work performed by individual team members. Lessons learned via iterative developments at USSTRATCOM

provide important guidance toward optimal knowledge wall usage, although further enhancements in this concept are anticipated as additional technical capabilities and products become available.

Decision-Focused Command and Control

Decision-Focused Command and Control (DFC2) is a concept that enables Joint Commands to dynamically manage and focus organization, processes, resources, and information across the enterprise to improve Situational Awareness and Decision Making. Synchronized "battle rhythm" is the mechanism that provides the warfighters across the enterprise with common views and goals in near real time.

CINC 21 Concept of Operations (CONOPS)

The CINC 21 C2 Concept of Operations (CONOPS) describes the information model across the enterprise. It includes the warfighter processes (types of common activities) and the information activities performed within each warfighter process. It includes a data model, process flows, and information flows/activities at nodes in the flow. If possible, timelines are useful.

Enterprise Command and Control Infrastructure

An enterprise command and control infrastructure was developed as part of CINC 21. The infrastructure consists of an aggregation of commercial and government off-the-shelf products running in an open standards environment. This infrastructure provided information-level services. These services allowed access, manipulation, display, and collaboration at the information level. The infrastructure components consist of the following components:

Enterprise Workstation

Enterprise Workstation is a common client workstation for USPACOM. It runs CINC 21 client and USPACOM client software on hardware with appropriate computational power and memory.

Enterprise Oracle® Database

Enterprise Oracle® Database is commercial software (8i or 9i) that provides persistence for the knowledge core in the infrastructure.

Enterprise Application Server

Enterprise Application Server was implemented via WEBLOGIC 6.1. It is the tool to provide interoperability of information through conversion to HTML format Enterprise Portal Server.

Enterprise Portal Server

Enterprise Portal Server was implemented via Digital Dashboard. Its purpose was to provide dynamically configured views of information layout.

Business Process Management Server

Business Process Management Server was not implemented but is expected to become part of CINC 21 during the transition phase (FY 2003 through 2004).

Knowledge Core (XML Data Services)

Knowledge Core (XML Data Services). The knowledge core is a collection of software servers that provide information "tagging" and persistence. The core provides tools for XML generation for geo-spatial products, web pages, and documents as well as indexing and retrieval of persistent information. It can operate locally or federated using XML parameters as pointers.

Decision-Focused Command and Control Applications

Decision-Focused Command and Control (DFC2) is implemented as a set of software components that facilitate management of organization, information, process and resource functions. The software components are organized in three layers (tiers): presentation, business process and data. These components provide information and knowledge navigation, status, product linking, decision summaries, and access control across the enterprise, along with a data schema (based on data model) that relates these components to the information in the data layer.

Presentation Layer

This layer is the interface to the warfighter. It provides the visualization of the underlying information to provide knowledge.

Decision Space Navigation Schema. This schema is a specification of the elements required to support the warfighters' visualization requirements.

Presentation Viewers. The hierarchical viewer is implemented as a tree for navigation and tables for information presentation. The battle rhythm viewer is implemented as a tree for navigation and a timeline for information presentation.

Shared Visualizations. These visualizations are layouts and web parts that provide access to the underlying knowledge core/objects. They provide a means to ask for information to be displayed, and they provide a way to actually present the information to the viewers from the common information in the knowledge core, including portal layouts, fonts, and colors.

Portal Configurations. These configurations are typical layouts that support the shared visualizations, including decision space, user management, and information management.

Business Layer

This layer is the logic (implemented as Enterprise Java Beans) that represents the command's business model. It manipulates the data/information to provide operational value to the warfighter.

Business Logic Utilities. These utilities are tools that provide capabilities such as time/date, filtering, and status rules.

Decision Space Management. These tools allow the creation, editing, copying, pasting, and deleting of business objects (operation, decision points, etc.). These objects can then be configured as hierarchical lists or timelines to navigate the decision space.

Information Management. These tools allow information product linking. These tools also track changes and provide alerts.

Business Process Management. These tools are for workspace management and workflow.

System Administration. These tools provide general user authentication with permissions and selected access.

Data Layer

This layer provides the actual interaction with data and information. The interaction is at the content level (XML Services)

Decision Space Data Schema. This schema is a specification of the data required to support the business process. It is the basis for the XML generated and accessed in the knowledge core.

Access Control Management. These tools provide the mechanisms for the System Administration to be executed at the data layer.

Pedigree Management. This tool provides tracking of persons making changes and times.

Schema Management. These tools facilitate changes in schema.

Operational Packages

The Operational Packages are applications that use the underlying enterprise architecture to provide new production capabilities for echelons below the decision-maker. These applications result in information stored in databases and available for supporting content that can be aggregated/rolled up for the decision-maker. They upgrade existing desktop-oriented applications or provide new capabilities to improve the Action-Officer-level tasks. These upgrades and new capability then provided metadata and persistence for information reuse. The following sections describe the operational packages.

Common Operational Picture/Geo-Spatial Visualization

Area of Responsibility (AOR) Basing

This application uses a GOTS decision aid (XIS ViewPoint) to manipulate and display information in a geo-spatial context. The application ingests three static databases (one is a browser-based access to the database). The application also ingests two dynamic sources. One source is a transportation-related web page where the information updates are pulled from the page and stored in a database, which is then ingested and manipulated as XML in the CINC 21 Knowledge Core. The second dynamic source is the Theater Logistics Operations Center hot spot. All the information ingested can be manipulated, overlaid, and interrogated for related information. All displays can be saved to the Knowledge Core for reuse and/or converted directly to PowerPoint.

Fused Battlespace View (FBV)

This tool is a joint USSTRATCOM/CINC 21 application that accesses and manipulates USSTRATCOM information. It is a JAVA program that accesses the USSTRATCOM Knowledge Core and displays their strategic information in a fixed structure. It provides a geo-spatial context with drill-down capability. It is tightly integrated to the USSTRATCOM operation process.

Briefing/Information Summary

Consequence Management Automated Brief

This brief is a CINC 21-developed application. Its purpose is to get briefing information in a database where it can be reused and presented as PowerPoint, web pages, and directly as content to near real-time summaries. It provides a web form for data entry that is stored in the knowledge core. It can latter be manipulated as XML content, if desired. The actual capability is currently limited with some fixed formats as described by USPACOM users.

Course of Action (COA) Matrix

This matrix CINC 21 application was developed for USSTRATCOM and provides a data model based on the DFC2 schema that is implemented as a CINC 21 table with knowledge core drill-down. It provides a mechanism for aggregating and displaying top-level decision information and execution information. It also provides a mechanism for organized drill-down.

Status Tracking and Linking

Message Tracker

This tool is a CINC 21-developed application. It allows operators to read messages and link them to either an Operation or a Commander's Critical Information Requirements (CCIRs). This tool basically puts metadata to the messages and allows them to be imported to DFC2 based on the metadata. It is intended as a production tool that gets information to the knowledge core and allows reuse. The application is implemented as a JAVA server page.

Request for Information (RFI) Manager

Currently, this tool is a CINC 21 stand-alone application. It is not linked to the knowledge core at this time. At USPACOM headquarters, it uses local databases and web forms that link to the local database. This combination allows for a local capability to track requests and identify due dates, status, and responsible individual/organization. The tool has been used extensively in the venue for which it was originally conceived—at the Joint Task Force headquarters. It has been used operationally by III MEF and COMSEVENTHFLT. MARFORPAC and US Forces Japan are currently evaluating it for the RFI management software for their commands.

TeamApp

TeamApp is a web-based tool that provides a template for structuring and managing event information resources. The main feature provides participants (users or guests) access to all the information that is pertinent to a given event. Information is easily updated and sorted.

Time-Based Event Management

Task Management System (TMS)

The Task management System (TMS) provides a web-based structure for tracking various events. A task can be a request from an office to its subordinates to perform certain actions. A task can also be an item sent for a lower-level office to its parent offices for review and approval.

The TMS helps users to (1) track tasks from start to finish; (2) provide a single location for instructions, responses, documents, and e-mails for a task; and (3) archive task information for easier searching. It enables an organization to keep track of who is assigned to tasks, when tasks are due, and what the task is about.

Master Calendar

The USPACOM Master Calendar provides an integrated view of significant events relevant to the Commander and the headquarters staff. The display is used for event de-confliction and general situational awareness of important events affecting the command. The application is a web-based tool, resides on the headquarters Intranet system and operates within the TeamApp environment. The interface allows users to choose and toggle between multiple event displays, including a standard monthly event calendar view, and Gantt views that show how events overlap over extended periods of time. These displays can be customized and filtered to display only event information relevant to a particular user.

JWID Coalition Information Interoperability Network (COINS)

The Coalition Information Interoperablity Network (COINS) is an operational package that provides interoperability of coalition (U.S., UK, CA, AU) information at the information content level. It was used in JWID 02. It uses the Enterprise C2 Infrastructure with special focus on the knowledge core and XML services.

Composable Frames

Composable Frames, an early example of web-based technology, was only used in preliminary demonstrations and only assessed informally.

Displays

Group Displays: Large Screen (Standard Resolution)

The USPACOM video wall is a 3 x 9 matrix of 21-inch video monitors that are affixed to a wall and used to display desktop views.

Group Displays: Large Screen (High Resolution)

Six 4 foot x 5 foot cubes are arranged in a 2 x 3 matrix. The total size of the display is 8 feet x 15 feet with a 1280 x 1024 cube-to-cube resolution. Activu Control Manager and Gateway and Activu Display software run on two servers to drive the matrix of the display cubes.

Workstation Displays: Multiple Side-by-Side Flat Monitors

These monitors are commercial flat panel displays that are relatively inexpensive. They require an appropriate video driver dictated by the client operating system and the display capability. They can be two or three-panel (or more) and provide a space for transforming information to knowledge by the user.

Workstation Displays: PV290 Multi-Screen Desktop Display

The Panoram PV290 DSK is a three-screen Liquid Crystal Display (LCD) monitor that is intended for use in various applied settings. Its major advantage relative to three conventional

monitors is that the three screens of the PV290 DSK are separated by a 0.625-inch wide bezel. This narrow boundary enables the PV290 DSK to present a more seamless image than conventional monitors, which typically have a 1.5 to 2-inch wide housing border, creating a 3 to 4-inch wide border between adjacent screens. The overall image size across its three equal-sized screens (18.1 inches diagonal) is 43.5 inches x 11.5 inches, making it approximately equivalent to three 19-inch monitors. The resolution of each screen is 1280 x 1024, resulting in an overall resolution of 3840 x 1024.

Collaboration

The collaboration services are a collection of software servers and products that support the Defense Collaboration Tool Suite (DCTS). There are Portal Enabled Extensions to DCTS that allow collaborations to run in portal environments. APIs for Embedded Collaboration is software that links collaboration spaces to DFC2 objects. Information Work Spaces (IWS) were also made available to groups of operators.

Network Operations Tools and Services

The network operations aggregate commercial applications information through the CINC 21 knowledge core. The applications are ingested in the knowledge core with their XML tags. This information is then aggregated and displayed as tables (in near real time) via business rules. The presentation is a matrix with drill-down capability that presents the state of operational servers and networks. Network operations were supported by monitoring and information assurance tools.

Theater C4ISR Status Grid

This grid is a graphic display, broken down by theater organization and type of resource. It displays a rollup of the Remedy Trouble Ticket Workflow tickets assigned to each location and resource. A drill-down capability allows the operator to see the actual ticket.

Network Operations Status Monitoring

Remedy Trouble Ticket Workflow

The Remedy Trouble Ticket Workflow system runs the Network Monitoring Tools. It processes open tickets (network problems) into an XML formatted file that represents the status of resources located within the theater organization. The representation drives the Command, Control, Communications, Computers, Intelligence, and Reconnaissance (C4IR) Status Grid display and integrate with other systems.

Events Involving Critical Servers (EICS)

The Events Involving Critical Servers (EICS) monitor is an information assurance monitor that allows an operator to describe a set of critical servers in terms of easily understood aliases. It shows the total number of times the server has been an attacker or has been attacked.

Event Priority Chart (EPC)

The Event Priority Chart (EPC) is an information assurance tool that shows Automated Intrusion Detection Environment (AIDE) system event activity over the last 30 days.

Link Analysis Tool

The Link Analysis Tool is an information assurance tool that displays three categories of nodes: external, internal, and critical. Links are drawn between nodes to indicate attacker/attackee relationships.

One-Way Proxy

The One-Way Proxy is an information assurance tool that allows secure transport of data from a low security network to a high security network.

Battle Management Center (BMC) Patrol

Battle management Center (BMC) Patrol is a commercial product. It is an automated discovery process that understands not only when major failures occur, but also interprets the accumulation of minor events that lead to customer-service-level degradation. The hardware, software, and processes define customer- centered, service-level management.

Network Operations Capability Brief

The Network Operations Capability Brief describes the network capabilities of the entire theater. It was developed to be dynamically updated, based on what is in the Remedy Trouble Ticket Workflow system and what has been entered as the mission impact statements.

Special Projects

Special projects were single attempts to develop a specialized tool or application. In some cases, they were hardware or software applications that supported the enterprise infrastructure for a particular phase of the ACTD, but were found to be unnecessary or replaced as the ACTD concepts matured. The following sections describe these special projects.

USSTRATCOM Portal

The USSTRATCOM Portal is a USSTRATCOM/CINC 21developed visualization. It is integrated to the USSTRATCOM knowledge core and allows interoperability with the FBV through the knowledge core. It presents the command's information via a series of portal views.

JWID Administrative Portal

This was a specialized developed visualization to support the 2002 Joint Warfighting Interoperability Demonstration (JWID). It was an initial instantiation of portal technology. It was designed to support the daily events of the JWID exercise. It was superseded by more advanced portal technology.

Time-Step Virtual Private Network (VPN)

Virtual Private Networks (VPNs) were used to provide encapsulation and encryption to protect against external tampering and eavesdropping. TimeStep VPN Gateways provided DCTS collaboration capabilities for USSTRATCOM users interfacing with USPACOM and Advanced Information Technology Services (AITS)–Joint Program Office (JPO) users. The VPN gateway at the AITS-JPO was configured to support split tunneling, with traffic to/from USSTRATCOM IP addresses getting encrypted/unencrypted, while all other traffic was configured to pass

through the VPN Gateway in “clear” unencrypted mode. This allowed users in USPACOM without VPN capability to connect to a collaboration server at the AITS–JPO that was linked with USSTRATCOM, supporting collaboration sessions with all sites.

Quality of Service (QoS)

Quality of Service (QoS) is a set of capabilities that allow creation of differentiated services for network traffic, thereby providing better service for selected network traffic. With QoS, you can increase bandwidth for critical traffic, limit bandwidth for non-critical traffic, and provide consistent network response. Implementing QoS can allow the efficient use of expensive network connections.

Remote Routing Access Server (RRAS) VPNs with Public Key Infrastructure (PKI)

CINC 21 fielded the Microsoft® Remote Routing Access Server (RRAS) to provide better VPN client support. The RRAS server worked with the VPN client that comes with Windows® 2000, strict lockdown procedures were performed on the RRAS server, and users were given Public Key Infrastructure (PKI) certificates for user authentication.

VOIP Suite

The Cisco® Voice Over Internet Protocol (VOIP) Call Manager software and Internet Protocol phones were provided.

Internet Protocol, Version 6 (IPv6)

Using the IPv6 standard, a native test bed was built to provide communications over the Unclassified Defense Information Systems Network (DISN)-Leading Edge Service (LES) network.

NETIQ

NetIQ is a network performance-monitoring tool. It was provided for the JWID '02 exercise. It measures server performance and network bandwidth availability.

NET VCR

The Network VCR provides detailed performance measurements and playback capability of traffic to critical CINC 21 servers.

Multi-Router Traffic Graphing (MRTG) Tool

The Multi-Router Traffic Graphing (MRTG) tool was provided to collect and graph aggregate traffic on router and switch ports.

3Com® Embedded Firewall (EFW) Network Interface Cards (NIC)

The 3Com® Embedded Firewall (EFW) technology was provided to prevent insider attacks and outside hacks by placing a low-cost, easy-to-use network access control point directly in front of each critical host on the network. The EFW network access control point is independent of the host and controls all accesses to and from the host. It protects the network from attacks launched from the host itself, as well as protecting the host from network attacks. It also means a user or

malicious code that gains access to administrator mode on the host cannot modify the configuration of the access control point.

Tactical Logistics Operations Center (TLOC)/Joint Military Command (JMC)Support

Tactical Logistics Operations Center (TLOC)/Joint Military Command (JMC) is CINC 21 technical support work that included the composable frames operational package and day-to-day implementation and improvements on-site to accommodate JMC/TLOC users. It also included daily web page data "scraping" and manual data evaluation (vetting).

Navy Marine Corps Internet (NMCI) Certification/Cut Over

Navy Marine Corps Internet (NMCI) Certification/Cutover supported the NMCI transition. It included software information and testing.

Products and the ICF

Table 1 provides a summarization of CINC 21 technologies as they relate to the ICF components depicted in Figure 1. Table 1 also indicates which of the CINC 21 technologies were directly evaluated as part of the Joint Military Utility Assessment.

Table 1. ICF components and CINC 21 technologies.

ICF Categories	ICF Components	CINC 21 Technologies	Direct Assessment?
Process and Support Components	Process		
	Manpower		
	Training		
	Provisioning		
	Facilities	Enterprise Workstation	No
		Group Displays (Std Res Large Screen)	Yes
		Group Displays (High Res Large Screen)	Yes
		Workstation Displays (Flat Panels)	Yes
		Workstation Displays (PV290)	Yes
Infrastructure and System Components	Collaboration	Collaboration Services	Yes
	Applications	DFC2 Presentation Layer	Yes
		Enterprise Oracle® Database	No
		Enterprise Application Server	No
		Enterprise Portal Server	No
		Business Process Management Server	No
		Area of Responsibility Basing	Yes
		Fused Battlespace View	Yes
		Consequence Management Automated Brief	Yes
		Message Tracker	Yes
		Request for Information Manager	Yes
		Course of Action Matrix	Yes
		Master Calendar	Yes
		Task Management System	No
		Composable Frames	Yes
		JWID COINS	No
		TLOC/JMC Support	Yes
		STRATCOM Portal	Yes
		JWID Administrative Portal	
	Info Management	DFC2 Data Layer	No
		Knowledge Core	No
		TeamApp	Yes
	Network Info Distribution	DFC2 Business Layer	No
		Quality of Service	Yes
		IPv6	Yes
		NetIQ	Yes
		NET VCR	Yes
		MRTG	Yes

Table 1. ICF components and CINC 21 technologies. (continued)

ICF Categories	ICF Components	CINC 21 Technologies	Direct Assessment?
Infrastructure and System Components (continued)	Info Assurance	BMC Patrol	Yes
		Theater C4ISR Status Grid	Yes
		Network Ops Capability Brief	No
		Network Operations Status Monitoring:	Yes
		Remedy Trouble Ticket Workflow	
		Events Involving Critical Servers	
		Event Priority Chart	
		Link Analysis Tool	
		One-way Proxy	
		VOIP Suite	No
		VPN	Yes
		Time-Step	
		RRAS VPNs with PKI	
		3COM® EWF NIC Cards	Yes
		NMCI Certification/Cut-Over	No
	Network Transport		
Planning Components	Planning Policy Architecture	Enterprise Architecture	No
		Optimal Knowledge Wall Usage	No
		Decision-Focused Command & Control	No
		CINC 21 Concept of Operations	No

Why Develop CINC 21?

Operational Concept

The operational concept for CINC 21 is a knowledge-enabled information sphere with tools and applications to (1) improve situation awareness and understanding, (2) facilitate the ability to collaborate when necessary, and (3) manage the information enterprise while transforming and accelerating the decision processes that underlay the management of crisis-contingency operations, theater 7 in improved processes, thereby increasing overall headquarters readiness, efficiency, and mission effectiveness.

The four Critical Operational Issues (COIs) were:

- COI-1: Can advanced visualization technology empower individuals to process, digest, and assimilate large volumes of information, enabling faster, more effective decisions?
- COI-2: Can knowledge management technology integrate information, context, and rules to increase understanding and improve decision-making?
- COI-3: Can collaboration tools be employed to overcome tyrannies of time, distance, and system disparity?
- COI-4: Can the collection of networks, databases, and applications be enhanced to optimize the flow of information, with security assurance, across multiple network enclaves?

Requirements

The COIs reflect the objectives of the ACTD and are supported by 44 detailed activity requirements. These requirements were prioritized and grouped according to the four COIs as displayed in Table 2. Although the CINC 21 technology products that were developed focused on the top 27 priority requirements, the products also addressed many of the other 17 requirements. Only nine requirements did not have any applicable technologies.

Table 2. Prioritized requirements grouped by COI.

Priority	System Requirement	COI	Technology
1	Develop the standard desktop client workstation configuration and software to allow command/staff organic support (CINC 21-configured desktop workstation).	1 – Decision-Focused Visualization	EWS (not assessed directly)
2	Provide domain-independent mechanisms for dynamically tailoring the presentation of information to a decision-maker based upon their activities.	1 – Decision-Focused Visualization	DFC2 COA Matrix FBV AOR Basing TCCC Conseq. Mgt.
3	Provide domain-independent mechanisms for displaying linkages between related events/items within and across windows, including drill-down.	1 – Decision-Focused Visualization	DFC2 COA Matrix FBV AOR Basing Message Tracker
4	Provide generalized XML-capable browser and integrate with the Knowledge Management (KM) database.	1 – Decision-Focused Visualization	DFC2 STRATCOM Portal
5	Provide open, extensible geo-situation software that allows acceptance of data and geo-rendering with complete filtering, labeling, and overlay control.	1 – Decision-Focused Visualization	XIS provided as part of AOR Basing (not assessed directly)
6	Provide the standard distributed collaboration software client configuration and software to allow command/staff organic support to users.	3 – Collaboration	DCTS
7	Develop a thematic collaboration system that ingests information, produces summaries and links it to other information articles, allows analysis and collaboration.	3 – Collaboration	DFC2
8	Develop a solution for secure authentication on SIPRNET among the COCOM's staff, Joint Task Forces (JTFs), and Components.	4 - Security	User Management
9	Provide tools for monitoring and visualizing information flows across the theater based upon content, priority, and purpose.	4 – Enterprise Awareness	DFC2 COA Matrix FBV AOR Basing
10	Provide tools for constructing and viewing the Information Assurance COP.	Not addressed	
11	Provide unclassified restricted (e.g., NIPRNET) conference server to support multiple distributed collaboration sessions internal to DoD.	3 - Collaboration	DCTS

Table 2. Prioritized requirements grouped by COI. (continued)

Priority	System Requirement	COI	Technology
12	Develop a secure mechanism that enables collaboration tools to work in the presence of firewalls.	4 - Security	DCTS IWS VPN
13	Provide a secret conference server to support multiple distributed collaboration sessions with US units.	3 - Collaboration	DCTS IWS
14	Provide unclassified, unrestricted conference server to support multiple distributed collaboration sessions with organizations and agencies external to US DoD.	3 - Collaboration	DCTS
15	Field collaboration tools to the COCOM, JTF, and Component Commanders that provide VTC, voice, instant messaging, shared virtual workspace, shared whiteboard, and shared applications.	3 - Collaboration	DCTS IWS
16	Implement a solution to achieve run-time interoperability among different collaboration tools.	3 - Collaboration	Collaboration tools
17	Provide mechanisms for automatically setting up and managing collaboration sessions based upon workflow and operational priorities.	3 - Collaboration	DFC2
18	Develop a solution for securely connecting the COCOM to his Allied counterparts over unclassified networks.	4 - Security	VPN
19	Provide secret conference server to support multiple distributed collaboration sessions with allies.	3 - Collaboration	DCTS
20	Provide mechanisms for automating staging and distribution of knowledge objects throughout the theater (integrate with IDM).	2 - Knowledge Management	Enterprise C2 Infrastructure, DFC2, COA Matrix, and COINS
21	Provide the semantic constructs required for knowledge exchange for critical COCOM/JTF warfighting and theater engagement processes.	2 - Knowledge Management	DFC2
22	Provide tools that enable structured KM publishing processes that enable producers to publish their products as XML-based documents.	2 - Knowledge Management	Enterprise C2 Infrastructure

Table 2. Prioritized requirements grouped by COI. (continued)

Priority	System Requirement	COI	Technology
23	Build a knowledge portal for viewing and navigating through the COCOM's Ops-Intel Brief, SITREPs, and Electronic Battlebook.	1 – Decision-Focused Visualization	DFC2 JWID Admin Portal
24	Provide knowledge portals for the JTF and Allies that enable easy access to COCOM-provided support services.	1 – Decision-Focused Visualization	DFC2 JWID Portal
25	Implement data extraction and automated assembly mechanisms for automating significant portions of the COCOM's morning brief.	2 - Knowledge Management	DFC2 COA Matrix RFI Conseq. Mgt. TCCC Msg. Tracker
26	Develop automated brief preparation capability based upon content and update of the information/knowledge base.	1 – Decision-Focused Visualization	DFC2 Consequence Mgmt.
27	Develop consequence management and targeted briefing process.	1 – Decision-Focused Visualization	DFC2 Consequence Mgmt.
28	Develop the standard conference room configuration to allow command/staff organic support (CINC 21-configured conference room).	3 - Collaboration	DCTS IWS
29	Develop DTDs for OPLANs and CONPLANs.	1 – Decision-Focused Visualization	Enterprise C2 Infrastructure; Knowledge Core and DFC2: Decision Space Data Schema, Schema Management
30	Develop the dynamic TPFDD.	Not addressed	
31	Implement mechanisms for automating processes consistent with the workflow management system currently under development at PACOM.	1 – Decision-Focused Visualization	Task Management System (TMS)
32	Provide next-generation situation awareness, planning, and force execution tools to the COCOM and integrate with KM environment.	4 - Enterprise Awareness	DFC2 COA Matrix FBV AOR Basing
33	Provide the infrastructure that enables selected portions of the COCOM's networks to support prioritized delivery of products and bit-streams.	Not addressed	

Table 2. Prioritized requirements grouped by COI. (continued)

Priority	System Requirement	COI	Technology
34	Field advanced protocols to significantly reduce traffic latency of selected information flows through theater networks.	Not addressed	
35	Develop a creditable solution for auto-generation of security tags for archived data products based upon the current coalition release policy.	Not addressed	
36	Provide high-resolution, large-screen displays to the COCOM that are capable of supporting simultaneous crises and day-to-day operations.	1 – Decision-Focused Visualization	PACOM Video Wall STRATCOM K-Wall
37	Develop mechanisms for dynamically managing the pixel real estate of large displays to improve comprehension.	1 – Decision-Focused Visualization	PACOM Video Wall STRATCOM K-Wall
38	Provide alerting mechanisms that auto-initiate appropriate visualization events.	4 - Enterprise Awareness	DFC2 FBV TCCC
39	Implement homogeneous server–server federations.	4 - Enterprise Awareness	Enterprise C2 Infrastructure; Knowledge Core (XML Data Services) and DFC2 Schema management
40	Develop the standard mobile client workstation configuration and software to allow command/staff organic support (CINC 21-configured mobile workstation).	Not addressed	
41	Provide high-resolution, large displays to a JTF capable of supporting simultaneous crisis operations.	4 - Enterprise Awareness	STRATCOM K-Wall PV290
42	Provide a method for accessing knowledge objects across security enclaves with minimal latency.	Not addressed	
43	Prepare for the transition from Ipv4 to Ipv6 by performing selected experimentation and risk-reduction activities on selected theater networks.	Not addressed	
44	Provide multi-modal human–computer interface capabilities (e.g., voice, head-tracking, gesture, hand-pointing).	Not addressed	

Who Had Assessment Responsibility?

Organizational Responsibilities

The principal organizations that executed CINC 21 were Deputy Under Secretary of Defense (DUSD) Advanced Systems & Concepts (AS&C), United States Pacific Command (USPACOM), United States Strategic Command (USSTRATCOM), Office of Naval Research (ONR), Defense Information Systems Agency (DISA), SPAWAR Systems Command (SPAWAR), DUSD Science & Technology (S&T), Defense Intelligence Agency (DIA), and Defense Threat Reduction Agency (DTRA). USPACOM was the sponsoring COCOM and provides the Operational Manager for the ACTD. ONR and DISA shared the responsibilities of Technical Manager. SPAWAR acted as the Transition Manager for the CINC 21 ACTD. US PACCOM and USSTRATCOM provided the operational settings for the ACTD.

USSTRATCOM provided:

- Participation in demonstrations/operations
- Input on military utility of technologies

USPACOM provided:

- Operational Manager
- On-site technical and installation support to Technical Manager
- Constant oversight of operational/user requirements
- Concept of Operations development
- Leadership for Joint Military Utility Assessment activities
- Participation in demonstrations and operations

Operational Manager

The user sponsor, USPACOM, served as the Operational Manager. The Operational Manager had overall responsibility for Concept of Operations development, requirements definition, and military utility assessment. The Operational Manager lead the planning, execution, and reporting of the military assessment and assisted the Technical Manager in overall ACTD planning and development activities.

USPACOM served as the warfighter sponsor for the CINC 21 ACTD. USPACOM designated the Chief Information Officer (CIO) as the Operational Manager for CINC 21.

Specific responsibilities included the following:

- Develop, plan, and conduct JMUA.
- Develop metrics to measure C2 effectiveness.
- Identify opportunities for demonstrations.
- Report JMUA findings and recommend for transition or termination.

Military Utility Assessment Manager

The Military Utility Assessment Manager was responsible for measuring the effectiveness of the ACTD products in improving operational capabilities and reporting the findings to the Operational Manager along with a recommendation on military utility. Military utility is a judgment of the military worth of a proposed capability. The assessment was accomplished by evaluating performance measured in an operationally realistic environment against critical operational issues. The assessment considered operational effectiveness and suitability in performing the assigned mission and overall importance to the success of the military operations in judging military worth. The Military Utility Assessment Manager was responsible to the Operational Manager for the following:

- Identifying, planning, and coordinating assessment opportunities.
- The exercises, demonstrations, and day-to-day operations provided continuous opportunities to assess CINC 21 technologies for military value and provide feedback to the technical development, integration, and transition efforts.
- Developing a set of performance measures, an approach to provide maximum feedback, ensured technologies were assessed quickly.

How Was CINC 21 Assessed?

General Approach

Based on the Ultimate Operational Issue (UOI), COIs, CINC 21 objectives, and prioritized requirements, a JMUA plan (Appendix B) was developed to evaluate CINC 21 capabilities for acquiring, processing, analyzing, and presenting information needed for better decision-making, improved processes, increased overall readiness, efficiency, and mission effectiveness. Measures of effectiveness (MOEs) were defined along with subsequent measures of performance (MOPs) and metrics to assess the CINC 21 products in an operational setting.

MOE Development Process

After several iterations, an initial JMUA plan was developed in January 2001 (Appendix B). This plan summarized an approach and proposed a group of metrics for examining how well the CINC 21 technologies support the Combatant Commander information and decision processes. After development and integration of many of the CINC 21 technologies, mission areas were defined as the context for compiling a more detailed JMUA plan.

A CINC 21 Assessment Workshop was held in San Diego, CA, on 23–25 January 2002. While hosted and chaired by the JMUA team, attendees included all the major participants of the CINC 21 ACTD: the Deputy Technical Manager, the Deputy Operational Manager, the Military Utility Assessment Manager, the Transition Manager, the development trust leaders, and representatives from the technical development team. The participants included representation from USPACOM and USSTRATCOM. Work groups proposed a number of information requirements as components of the JMUA, based on the planned technology products of CINC 21. The major outcome of the workshop was a set of MOEs that expanded the COIs.

For each COI, one or more MOEs that transform the COI into a statement of measurability were defined. The MOEs are high-level statements that summarize the extent to which a system accomplishes or supports a mission or task, and are designed to address an individual COI. MOEs are not necessarily exhaustive. Rather, a comprehensive set of MOEs that adequately address the expected improvements by each group of deliverables has to be defined. Each MOE is defined in more detail by one or more MOPs. MOPs are qualitative or quantitative measures of a system's capabilities or specific performance function. Finally, metrics are defined as specific measures used to address the MOPs.

The process used in defining assessment requirements and then transforming these into specific measurements, is shown in Figure 3. The assessment targets are the final deliverables, as defined by the CINC 21 ACTD.

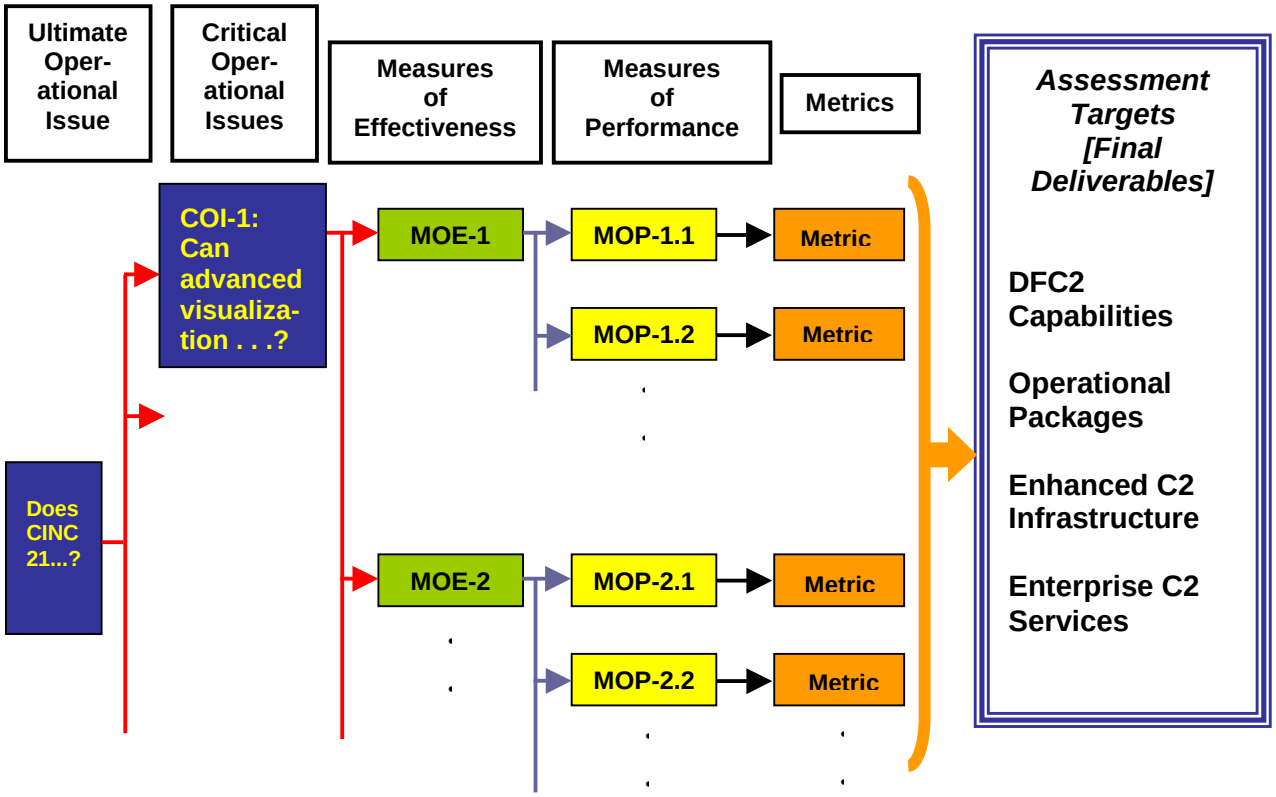

Figure 3. Defining assessment requirements and developing specific measures.

Military Effectiveness Criteria

Comprehensive assessment involves layers of measurement, including the determination that (1) enabling hardware and software function adequately; (2) personnel were adequately trained to operate new technology, and can use the technology to do their work; and (3) performance of key selected functions or part-tasks has improved as expected. Consequently, as shown in Figure 4, the Joint Military Utility Assessment (JMUA) addresses the following effectiveness criteria:

- *Suitability* – Are operational requirements met?
- *Usability* – Are CINC 21 products easy to learn and use?
- *Technical foundation*
  - *Supportability* – Are the products accommodated within the existing infrastructure?
  - *Accreditability* – Are services of CINC 21 products exportable?

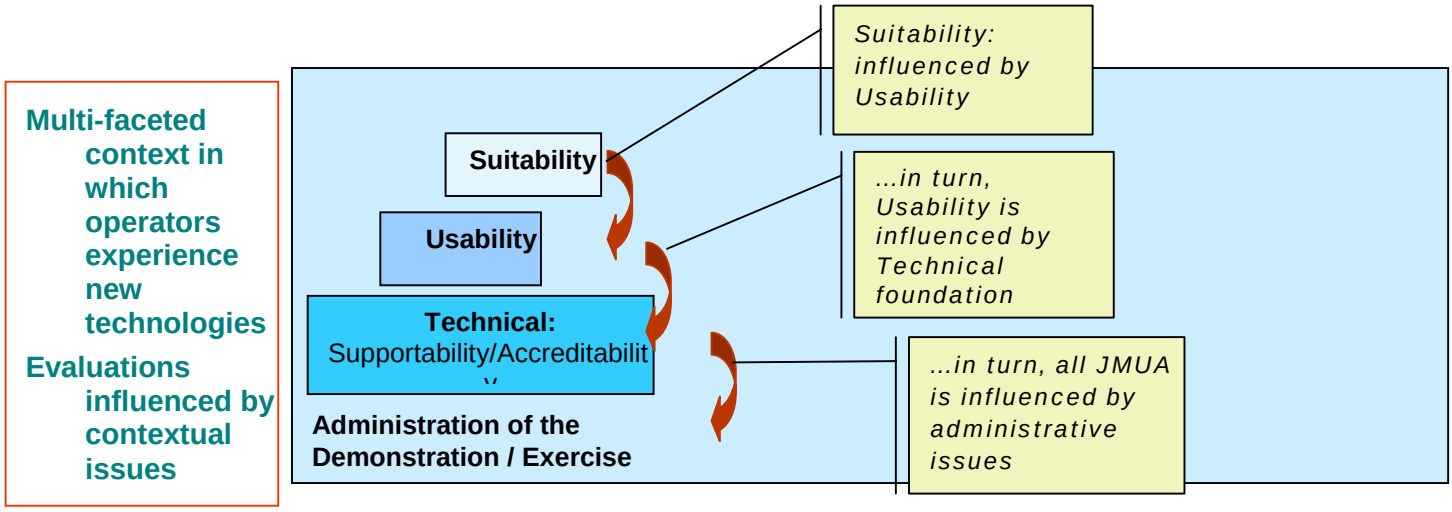

Figure 4. Military effectiveness criteria for assessing hardware and software.

Joint Military Utility Assessment Plan

Following the Assessment Workshop, the assessment team compiled a comprehensive set of MOEs that integrated the measurement requirements of the various work groups. Thirteen MOEs were defined in terms of quality, time, efficiency, and network operations:

Quality

- Quality of situation awareness and understanding among decision-makers is improved.
- Quality of decision-making is improved.
- Quality of collaborative operations is improved.
- Quality of collaborative planning is improved.
- Quality of information is improved.

Time

- Time it takes to reach decisions is decreased.
- Time to collaboratively plan is decreased.
- Time to relay information to decision-makers is decreased.

Efficiency

- Efficiency of information-sharing among distributed operations is improved.
- Efficiency of work processes is improved.
- Efficiency transmission of information among distributed operations is improved.

Network Operations

- C2 infrastructure provides security assurance across multiple networks, databases, and applications.
- Servers and applications are compatible and interoperable with existing services, applications, and network configurations.

The MOEs were mapped to the COIs to ensure sufficient coverage. Although some MOEs applied to more than one COI, Table 3 provides a summary of how the MOEs aligned with the COIs. These MOEs, with subordinate MOPs and metrics, were published in the *CINC 21 Military Utility Assessment Plan for FY 02/03* (Appendix B). The original MOEs have functioned with few changes as the foundation of data collection efforts for the project, despite changes in the direction of development efforts. A spreadsheet of these measurement criteria and data collected is located in Appendix C.

Assessment Methods and Events

CINC 21 assessment efforts were conducted throughout the technology development and integration period. Consequently, different sets of assessment methods and metrics from the JMUA Plan were employed as appropriate for the technology type, development maturity, and assessment environment. Trouble reports and technical observations/logs were analyzed to identify successes and problems associated with the installation and integration of the diverse set of CINC 21 products. The usability of CINC 21 products was assessed via several methods: (1) heuristic evaluations that compared the user interface against industry standards and guidelines, (2) informal comments and observations by representative users, and (3) structured ratings and performance tests of the user interface under scenario-based task conditions. The impact of CINC 21 products on organizational effectiveness and work processes was assessed in similar ways. The suitability of CINC 21 technology to support operational tasks was assessed via direct involvement by representative operational decision-makers and staff. They provided comments and ratings on the technology during several demonstrations and training sessions, and they were able to use the technology for their dynamic tasks in large-scale exercises.

In general, however, three types of assessment venues were used throughout the JMUA:

- Military Exercises and Demonstrations
- Limited Assessment Opportunities
- Technical Evaluations (includes human–computer interface evaluations)

Assessment data were collected at three types of events: military exercises/demonstrations, limited assessment opportunities (LAOs), and human–computer interface (HCI) evaluations by expert human factors reviewers. Table 4 shows the specific CINC 21 technologies that were assessed during various military exercises or demonstrations.

Table 3. COI to MOE mapping.

COI	MOE
COI-1: Can advanced visualization technology empower individuals to process, digest, and assimilate large volumes of information, enabling faster, more effective decisions --- **COI-2**: Can knowledge management technology integrate information, context, and rules to increase understanding and improve decision-making?	**Quality** Quality of situation awareness and understanding among decision-makers is improved. Quality of decision-making is improved. **Time** Time it takes to reach decisions is decreased.
COI-3: Can collaboration tools be used to overcome tyrannies of time, distance, and system disparity?	**Quality** Quality of situation awareness and understanding among decision-makers is improved. Quality of collaborative operations is improved. Quality of collaborative planning is improved. **Time** Time it takes to reach decisions is decreased. Time to collaboratively plan is decreased. **Efficiency** Efficiency of information sharing among distributed operations is improved.
COI-4: Can the collection of networks, databases, and applications be enhanced to optimize the flow of information, with security assurance, across multiple network enclaves?	**Quality** Quality of information is improved. **Time** Time to relay information to decision-makers is decreased. **Efficiency** Efficiency of work processes is improved. Efficiency transmission of information among distributed operations is improved. **Network Operations** C2 infrastructure provides security assurance across multiple networks, databases, and applications. Servers and applications are compatible and interoperable with services, applications, and network configurations.

Large-scale military exercises and demonstrations afforded opportunities for the CINC 21 technologies to be used in high-fidelity tasks. Users and operational personnel who view the technologies "in action" can make pragmatic judgments of their military utility. In addition, usability and technical issues can be assessed.

LAOs are venues that are focused on a specific technology or capability. They are much more limited in scope than exercises or demonstrations, and they allow much tighter control of the assessment process. The task context is situationally specific. LAOs afford assessment personnel the opportunity to observe in-depth interactions between operational users and the technology and to gather detailed feedback regarding utility and usability issues. Assessment data were collected at LAOs for the following technologies: Decision-Focused Command and Control—Decision Space Management, Decision Summary, Chat, Battle Rhythm, Status Rule Management, and NetOps; AORB; Consequence Management Automated Brief; RFI Manager; Message Tracker; USSTRATCOM Knowledge Wall; Collaboration; TMS; and Master Calendar.

Table 4. CINC 21 Technologies at military exercises and demonstrations.

Military Exercise or Demonstration	CINC 21 Technology Assessed
Build 1 Technologies Demonstration Oct 00	Collaboration, Infrastructure and Security
Kernel Blitz Experimental KB(X) Jun 01	TeamApp, Collaboration
Joint Warrior Interoperability Demonstration (JWID) May 02	JWID Administrative Portal, JWID Coalition Interoperability Service (COINS), Collaboration, Infrastructure and Security
USSTRATCOM Consequence Management/ Response Demonstration Oct 02	FBV, USSTRATCOM portal, USSTRATCOM Knowledge Wall, Collaboration, COA Matrix
Terminal Fury '03 (TF03) Dec 02	Decision-Focused Command and Control: Decision Space Management, Decision Summary, Chat, Battle Rhythm, Status Rule Management

Technology experts familiar with the design and configuration of the technologies conducted technical evaluations. Human factors experts assessed human–computer interfaces using the CINC 21 *Style Guide*[2] or *Heuristic Evaluation–A System Checklist*.[3] The following technologies were assessed: Decision-Focused Command and Control—Decision Space Management and Status Rule Management; Consequence Management Automated Brief; RFI Manager; Message Tracker; USSTRATCOM Knowledge Wall; Multi-panel Display; JWID Administrative Portal; TMS; and Master Calendar. Computer systems experts evaluated the functioning of infrastructure and security systems.

[2] Pacific Science & Engineering Group. 2002. *User Interface Design Guidelines for Web Portals.* San Diego, CA.
[3] D. Pierotti. 2001. *Heuristic Evaluation–A System Checklist.* Xerox, Palo Alto, CA.

Results from individual assessment events were reported as they occurred throughout the CINC 21 project period. Many of these reports have been compiled and attached as appendices to this report. See the appendices to read the assessment of a specific CINC 21 product within a particular assessment environment.

Instruments

A wide variety of instruments were used to collect data during exercises, demonstrations, and limited-assessment opportunities, as shown in Table 5.

Selections of these instruments were adapted for the purpose of each individual assessment event, as shown in the assessment documents presented in the appendices.

Table 5. Descriptions of data collection instruments.

Instrument	Description
Training Assessment Form	A form was developed for administration at the completion of training to determine: (1) if sufficient training was received on the features of each technology, (2) the tasks to which the technology would be applied, and (3) if sufficient training had been received to apply the technology to work tasks.
Operational Utility	Each of the CINC 21 technologies were demonstrated or used. The users responded to questionnaires to assess the degree of operational utility.
Attitude Rating	The attitude measurement uses a technique of semantic differential, bi-polar adjective scales. The attitude form used four scales, with one selected from each group. These were (1) a Useless–Useful scale, (2) a Powerless–Powerful scale, (3) a Slow–Fast scale, and (4) a Chaotic–Orderly scale.
Human–Computer Interface Rating	A series of eight scales were selected that highlight major features of the interface between a human and the computer (Human–Computer Interface (HCI)). The eight-scale HCI instrument was intended to be administered twice to each participant, as critical design details may not be noticed until extensive use.
Situation Assessment Rating Technique (SART)	Situation awareness (SA) is the experience of fully understanding what is going on in a given situation, of seeing each element within the context of the overall mission or goal, and of having all the pieces fit together into a coherent picture. The Situation Awareness Rating Technique (SART) is a subjective SA method developed by Selcon & Taylor (1989)[4] for the UK Defense Evaluation and Research Agency.
Feature Utility	After using a technology, the participants could provide an assessment of the utilization of each of the technology's features for accomplishing their work. A one-page form was provided for each technology used by a participant, with fields to make a judgment of each feature with regard to (1) Needs to be fixed, (2) Mixed reaction, (3) Great as is, and (4) Not Used.
Task Workload Index (TLX)	The NASA Task Load Index is a thoroughly studied (Byers, Bittner, Hill, Zaklad, & Christ, 1988)[5] multi-dimensional subjective rating procedure that affords an overall workload score based on the weighted average of these six subscale ratings: Mental Demands, Physical Demands, Temporal Demands, Performance, Effort, and Frustration. In addition to the six scale scores, more typically an overall weighted measure of task load can be calculated based on the subscales.

[4] S. J. Selcon and R. M. Taylor. 1989. "Evaluation of the Situational Awareness Technique (SART) as a Tool for Aircrew Systems Design." *In Proceeding of the AGARD AMP Symposium on Situational Awareness in Aerospace Operations.* Advisory Group for Aerospace Research and Development, Neuilly Sur Seine, France.

[5] J. C. Byers. A. C. Bittner, Jr., S. G. Hill, A. L. Zaklad, and R. E. Christ. 1988. "Workload Assessment of a Remotely Piloted Vehicle (RPV) System." *Proceedings of the Human Factor Society 32nd Annual Meeting* (pp. 1145–1149). Human Factors and Ergonomics Society, Santa Monica, CA.

Table 5, continued.

Instrument	Description
Military Utility Assessment Questionnaire	Measures of Performance associated with each Measure of Effectiveness was stated as a question, and included in a questionnaire to be answered the participants.
Baseline Measures	Estimates of frequency, quantity, quality and timing were made by subject matter experts for current operations, to be used for comparison with new and alternative methods.
Australian Assessment Tool (AAT)	A web-based tool was used to collect data from participants in response to questions about their experience and specific questions generated by the study team. These data were entered through computer workstations at US-USPACOM, Canada, Australia, and UK. The data were collected into an integrated database for subsequent analysis.
Joint Battle Center Data Collection and Analysis Tool (JD-CAT)	A web-based tool was used to collect data from participants in response to questions about their experience and specific questions generated by the study team. These data were entered through computer workstations at US-USPACOM, Canada, Australia, and UK. The data were collected into an integrated database for subsequent analysis.
Observer (third party) data collection forms	Data collection forms were designed for observer data collectors to collect timing of specific events, observations associated with anticipated and unanticipated events, and impromptu participant verbal responses.
Interview forms	Measures of Performance associated with each Measure of Effectiveness was stated as a question and used as the basis for interviews with participants and individuals who watched demonstrations of the technology
Style Guide Checklist	A CINC 21 Style Guide was developed from a wide range of applicable human factors guidelines. A checklist was developed so that a human factors expert could rate an interface for each section of the style guide, using a scale of 1 to 7.
Heuristic Checklist	A Heuristic Checklist was compiled based on 14 rules (heuristics) that have been identified as characteristic of usable systems (Nielsen, 1993)[6]. Human Factors experts and/or users could rate a component of CINC 21 for each heuristic on a scale of 1 –to 7.

[6] J. Nielsen. 1993. *Usability Engineering*. Academic Press, Boston, MA.

Participants

Active duty military personnel and civilian personnel served as participants for CINC 21 technology assessment at the military exercises, demonstrations, and LAOs. Personnel affiliated with USSTRATCOM, USPACOM, First Marine Expeditionary Force (I MEF), and Commander Third Fleet comprised the participant pool. In addition, for the JWID, active duty military participants from Australia, Canada, and the United Kingdom were involved.

For the LAOs, participants were active duty military personnel, civilian personnel with background as military operational personnel, civilian personnel working in staff positions at USPACOM or USSTRATCOM, and civilian personnel working as researchers at Space and Naval Warfare Command Center, San Diego. CINC 21 assessment personnel were on hand to train and assist users to complete the appraisal tasks.

Statistical Analyses

When collecting data with human subjects, remember that results vary from person to person, and from time to time. Thus, the mean of data collected for Device A can differ from the data for Device B by chance, and consequently it is desirable to know the probability that such differences could occur by chance. However, one should know that it takes a quantity of data (repeated measurements) to derive a good estimate of this probability. Where possible with the data from various assessment events, statistical tests were performed as shown in Table 6. The reader is referred to the detailed appendices for more information about how these tests were used to assess specific technologies.

User responses to questionnaire items provided the bulk of the structured assessment data. Assessment data were analyzed mainly through descriptive statistics. In most of the assessment events, the number of participants was not large enough to warrant the use of inferential statistics. The exceptions were data from KB(X), where analysis of variance was used to analyze group differences in response to Situation Assessment Rating Technique (SART) scale items, and data from JWID, where chi-square analyses were applied to determine whether the results (responses to online Joint Battle Center Data Collection and Analysis Tool [JD-CAT] and the Australian Assessment Tool [AAT] questionnaire items) could have occurred randomly more often than one time out of twenty. Content analysis was used to distill interview, user comment, and observational data.

Table 6. Descriptions of statistical tests used during JMUA.

Statistical Test	Description
t-test for related measures	Test of the significance of the difference between two means, for example, ratings by the same individuals for two or more CINC 21 technologists. The statistical test yields the probability that the difference between the two means could be a chance occurrence.
Chi-Square test	For frequency data (e.g., counts of responses), the observed frequency can be compared to an expected frequency (e.g., frequency expected for no effect/change/improvement). The statistical test yields the probability that the effect/change /improvement was real rather than chance.
Analysis of Variance (ANOVA)	For selected data (e.g., Situation Awareness Rating Test), a statistical test could be conducted that compared the effects of multiple factors in the same analysis. Thus, the significance of each factor, and the interactions among factors, could be tested for chance occurrence.
Correlation Analysis	For selected data (e.g., Workload) a test was performed to determine if the results varied early versus late in an exercise.

Outcome

Data Collection Summary

The JMUA Plan identified an array of MOEs, MOPs, and metrics organized by mission effectiveness criteria that address the COI. Table 7 summarizes how many of these measures were collected at some point in the multi-method assessment process[7]. It refers only to the quantity, not the quality of data collected. This table, then, reports the breadth of the overall JMUA effort. Details are provided in the CINC 21 Products Technology Categories Section.

Table 7. Number of MOEs, MOPs, and metrics collected for Suitability, Usability, and Technical groupings.

MEASURE	MISSION EFFECTIVENESS CRITERIA				TOTAL
	Suitability	Usability	Technical		
			Supportability	Accreditability	
	"Are operational requirements met?"	"Are CINC 21 products easy to learn & use?"	"Are CINC 21 products accommodated within the existing infrastructure?"	"Are services of CINC 21 products exportable?"	
MOEs*	9 of 9	6 of 6	4 of 4	1 of 1	20 of 20
MOPs	26 of 33	12 of 12	6 of 6	3 of 4	47 of 55
Metrics	42 of 58	25 of 25	10 of 10	5 of 11	82 of 104

* There are 13 MOEs—some apply to more than one category. MOPs and metrics are specific to a category.

There are 13 MOEs. Data relevant to each of the 13 MOEs were obtained. The MOEs define desired improvements in output quality, time to produce output, efficiency of processes, or improvements to the C2 infrastructure. Subordinate to the MOEs, there are 104 metrics contained in 55 MOPs. Definitions of the MOEs and a summary of the MOPs (47 of 55) and metrics (82 of 104) for which data were obtained are shown in Table 8.

A coding scheme was assigned to the measurement criteria to facilitate their use during the design and execution of data collection efforts. That is, it was easier for assessors to refer to "metric A1-1" rather than "measurement of accuracy in understanding the operational situation" or "the first metric under the first MOP under the MOE that measure quality of situation awareness and understanding among decision-makers." The letters and numbers, therefore, have purpose or meaning only for identification of the measurement criteria. MOEs were assigned letters (e.g., MOE A). MOPs were designated by the letter of the associated MOE plus a number

[7] For details, see Appendix C.

(e.g., MOP A1, MOP A2). Metrics followed the same pattern, being assigned numbers consecutively as metrics were developed (e.g., metric A1-1, metric A1-2).

Table 8. MOE definitions.

MOE	Definition	MOPs measured	Metrics measured
A	The quality of situation awareness and understanding among decision-makers is improved.	4 of 4	9 of 10
B	The time to reach decisions is decreased.	3 of 4	4 of 5
C	The quality of decisions is improved.	2 of 3	4 of 7
D	The efficiency of information sharing among distributed operations is improved.	2 of 2	2 of 2
E	The quality of collaborative operations is improved.	4 of 7	9 of 17
F	The quality of collaborative planning is improved.	3 of 5	6 of 8
G	The time to collaboratively plan is decreased.	2 of 2	2 of 3
H	The quality of information is improved.	7 of 7	9 of 9
I	The efficiency of work processes is improved.	8 of 8	11 of 11
J	Efficiency of transmissions of information among distributed operations is improved.	4 of 4	11 of 11
K	C2 infrastructure provides security assurances across multiple networks, databases, and applications.	4 of 5	9 of 15
L	The time to relay information to decision-makers is decreased.	2 of 2	4 of 4
M	Servers and applications are compatible and interoperable with existing services, applications, and network configurations.	2 of 2	2 of 2

MOPs for which no data were collected are listed in Table 9.

With one exception, the MOPs for which no data were collected are subordinate to MOEs in the area of quality of output. Basically, the design of the assessment venues precluded the ability to gather data that would apply to these measures, as noted below:

- Tasks were very scripted (impacted C3, E5, E6, E7, F1, F5).
- Tasks relevant to the MOP were not performed (impacted B4).
- Specific metrics for MOP K4 were never defined.

Table 9. MOPs with no associated assessment data.

MOP	Definition
C3	The ability to recognize the need to make decisions improved.
E5	Quality of product was improved by collaboration.
E6	Team actions were better synchronized by collaboration.
E7	The team was more agile because of collaboration.
F1	Collaboration improved the quality of the plan produced.
F5	The quality of the COA alternative set improved.
B4	The time to stand up the JTF was faster.
K4	Command of the information enterprise was improved.

There are 22 metrics that were not used. Eight of these are subsumed under the MOPs described above. The remaining metrics with no data are listed in Table 10.

The inability to measure these metrics was due to the following:

- Tasks were very scripted (impacted A1-1, C2-1, C2-2, E2-2, E2-3, E2-4, G1-1). In addition, these types of metrics are more appropriate for comparison of intact, fully functioning teams with a history of performing these tasks so that comparisons can be made of baseline performance with performance using the new technology.
- Tasks relevant to the metric were not performed (impacted E4-5, E4-6, K1-1, K1-2).

Measurement of some metrics was beyond the scope of the assessment (impacted K1-4, K1-6, K3-2).

Table 10. Metrics with no associated assessment data.

Metric	Definition
C2-1	Rating of the extent to which the decision process conformed with consideration of critical uncertainties (expert judgment, answer key)
C2-2	Rating of the decision for completeness and appropriateness against organizational criteria.
E2-2	Common understanding of team goals.
E2-3	Commonality and accuracy in understanding independent players and team tasks.
E2-4	Number of times that key players take an action that undermines the tasks of another player. Number (fraction) of times that key players take an action that supports the task of other key players.
E4-5	Time to recognize need for a change in plan.
E4-6	Time to recognize need for a decision.
G1-1	Start and stop times required to develop mission and intent.
K1-1	Number of successful controller attempts to monitor network operations vs. total controller attempts to monitor network operations.
K1-2	Number of detected intrusion attempts vs. total intrusion attempts.
K1-4	Ability of controllers to identify redundant data transmission paths.
K1-6	System administration requirements stay within acceptable workload parameters.
K3-2	Number of applications/service failures vs. total attempts to access applications/services.

Assessment Summaries

This report attempts to aggregate across each of these individual assessments to provide an integrated summary of military utility. We realize, however, that readers will need different types of assessment summaries, aggregated in different ways. One way in which we report the assessment data is in terms of the CINC 21 products themselves. For ease of presentation, we have summarized these by technology categories. These assessment summaries reflect the measures of effectiveness, measures of performance, and associated metrics identified in the CINC 21 JMUA Plan. In addition, there is a brief discussion of technical issues, tradeoffs, and lessons-learned during the installation and integration of the products and infrastructure. The assessment data have also been summarized in terms of the prioritized CINC 21 system

requirements and capabilities. Each of these views of the assessment data has been combined to show their relationship to the four CINC 21 COIs.

The military utility assessment of CINC 21 technology, then, is seen as a multi-dimensional hierarchy. The most elemental assessments of CINC 21 products in particular tests or exercises can be combined to provide summary evaluations of various technology categories, system requirements, and other dimensions. Ultimately, these evaluations may be aggregated to provide a summary assessment for each COI. Of course, some degree of subjectivity is necessary to make these aggregate judgments. This subjectivity has been controlled by cross-referencing back to the fundamental test data and by seeking input from all CINC 21 stakeholders in reporting these summary assessments.

Throughout this document, non-textual summary indicators using the stoplights metaphor are provided at four levels:

1. The individual technologies.
2. Technology categories—groupings of individual technologies.
3. COIs—groupings of technology categories.
4. Prioritized Requirements—Operations Manager-identified stipulations for advanced information technology

At each of these levels, a rating is provided for the following issues:

- Suitability—Are operational requirements met?
- Usability—Is the technology easy to learn and use?
- Technical—Are CINC 21 technologies accommodated within the existing infrastructure, and can their services be securely exported?

These summary indicators are meant to provide the reader with a means to scan the results. Much detail is necessarily lost in these summaries as myriad data points are combined into a three point scale; it is, therefore, strongly suggested that readers do not rely on these summary ratings without a thorough review of the finer level analyses.

The ratings at the summary indicators were attained by applying the following guidelines:

GREEN: A preponderance of the MOPs were rated as Positive Findings rather than as Remaining Challenges, AND any Remaining Challenges are judged to be **insufficient to have a negative impact** upon the achievement of objectives or upon future development efforts.

YELLOW: Either (1) an approximately equal number of MOPs were rated as Positive Findings and Remaining Challenges, OR (2) there are any proportion of Positive Findings with one or more Remaining Challenges that are judged to have **limited the achievement** of objectives, or to have a **moderate negative impact** upon future development efforts. These Challenges **should be the focus** of development efforts.

RED: Either (1) a preponderance of the MOPs were rated as Remaining Challenges rather than as Positive Findings, OR (2) there are any proportion of Positive Findings with one or more Remaining Challenges that are judged to have **prevented the achievement** of objectives, or to have a **major negative impact** upon future development efforts. These Challenges **must be resolved** before the continuation of development efforts.

The scale used was as follows:

	GREEN	Meets requirements with minor modifications.
	YELLOW	May meet requirements with significant revisions.
	RED	Does not meet requirements.

In addition, the following symbol was applied if it was not possible to make an evaluative rating:

	B&W	This requirement was not addressed by CINC 21 or was not addressed sufficiently to allow for assessment.

CINC 21 Product Technology Categories

A complete list of CINC 21 products along with descriptions is provided in the What is CINC 21? section of this report. For assessment purposes, these products have been reorganized into a series of technology categories that reflect the functional capabilities presented to CINC 21 users. That is, the CINC 21 products with which users would interact directly have been clustered into categories that roughly correspond with the capabilities that they provide.

The CINC 21 products that are listed under the Concepts heading were not assessed. In general, concepts do not lend themselves to assessment. Usually, concepts have to be assessed via the specific technologies designed and developed to implement them. It is only after incremental successes that evidence for or against the concept emerges. With ACTDs, the concepts generally continue to evolve over the life of the program. Thus, a formal military utility assessment is an inappropriate method to evaluate concepts. In addition, the CINC 21 products that are strictly infrastructure necessary to use other products were generally not included in the assessment. Infrastructures are the means to an end. In general, most technologies require some infrastructure before they can be implemented, e.g., it would be difficult to evaluate a high-speed graphics capability without first ensuring that the platform and existing software are sufficiently upgraded to support the new capability.

Decision-Focused Command and Control (DFC2)

Decision-Focused Command and Control (DFC2) is a set of applications that facilitate management of organizational, information, process, and resource functions. DFC2 applications are characterized as three inter-related layers: Presentation, Business, and Data.
[see description]

DFC2 products were in an early stage of development during the JMUA. As such, only a few of the applications were directly assessed. To the extent that these applications were dependent on

various components of the other layers, it is appropriate to assume that the assessment results are applicable to those applications, as well. Specific data were collected on the following:

- Decision Space Management [see results]
- Decision Summary [see results]
- An information management utility, Chat (embedded) [see results]
- A time-oriented Presentation Viewer, Battle Rhythm [see results]
- A business logic utility, Status Rule Management [see results]

Operational Packages

The Operational Packages are CINC 21-developed applications that use the underlying enterprise architecture. These applications were categorized according to related capabilities and include:

Common Operational Picture/Geo-Spatial Visualization

This category is comprised of two independent CINC 21 products. Both products were assessed in separate venues.

- Area of Responsibility Basing (AORB) [see results] [see description]
- Fused Battlespace View (FBV) [see results] [see description]

The products in this technology category have the common objective of providing operational decision-makers and supporting staff improved situation awareness and understanding through manipulation of graphics of information relevant to the area of operations.

Briefing/Information Summary

Several CINC 21 products provide a means for operational personnel to prepare and disseminate summarized information, which is used to promote situation awareness and comparison of decision options.

- Consequence Management Automated Brief [see results] [see description]
- Course of Action (COA) Matrix [see results] [see description]

Status Tracking and Linking

Three independent CINC 21 products were developed and assessed that assisted operational personnel working in a distributed, collaborative environment to organize and monitor task-related information.

- Message Tracker [see results] [see description]
- Request for Information (RFI) Manager [see results] [see description]
- TeamApp [see results] [see description]

Time-Based Event Management

Two independent CINC 21 products were developed to improve distributed staff awareness of pending tasks and schedules. These products permitted users to manipulate and display task-related information chronologically.

- Task Management System (TMS) [see results] [see description]

- Master Calendar [see results] [see description]

JWID Coalition Interoperability Service (COINS)

The Operational Package, JWID COINS, is a knowledge management tool that was assessable but was not part of the infrastructure of other CINC 21 products. In general, Knowledge Management is the set of core services that includes software servers and applications for information manipulation and information persistence. Most CINC 21 products in this category are the services that are a result of the infrastructure applications. [see results] [see description]

Displays

The CINC 21 displays consisted of group and workstation products.

Group Displays

This category is comprised of two independent group display products. These technologies are intended to allow co-located personnel to reach common understanding of an operational situation through viewing shared information on a large screen.

- USPACOM Video Wall (standard-resolution large screen display) [see results] [see description]
- USSTRATCOM Knowledge Wall (high-resolution large screen display) [see results] [see description]

Workstation Displays

Several workstation multi-screen display configurations were examined as CINC 21 products. These products were intended to increase the efficiency of work efforts via concurrent display of task-relevant information. Multiple screens could enable users to have multiple active applications and to manipulate data in one application while monitoring others.

- Multiple side-by-side commercial flat panel monitors [see results] [see description]
- PV290 multi-screen desktop display (integrated three-screen console) [see results] [see description]

Collaboration

Several collaboration products were explored as part of CINC 21. These products were intended to allow distributed operational personnel to synchronize their battle rhythm and perform distributed decision-making. [see results] [see description]

- DCTS and its component technologies
- Information Work Space (IWS)

Network Operations Tools and Services

The network operations use a series of applications to provide a Theater C4ISR Coordination Center (TCCC) display for viewing the operational status of networks. Products assessed include the following:

- Theater C4ISR Coordination Center Status Grid [see results] [see description]
- Network Operations Status Monitoring, including: [see results] [see description]

  - Remedy Trouble Ticket Workflow (from which is derived the TCCC Status Grid)
  - EICS tool
  - Events Priority Chart tool
  - Link Analysis tool
  - One-Way Proxy tool
- BMC Patrol [see results] [see description]

The Network Operations Capability brief is still under development and was not assessed.

Special Projects

The special projects were single attempts to develop a tool or application for a specific use. In some cases, they were hardware or software applications that supported the enterprise infrastructure for a particular phase of the ACTD, but they were unnecessary or were replaced as the ACTD concepts matured. Most of these projects involved hardware or software that did not lend themselves to a meaningful assessment other than to verify proper installation and operation. The special projects that were assessed, include:

- USSTRATCOM Portal [see results] [see description]
- JWID Administrative Portal [see results] [see description]
- QoS [see results] [see description]
- VPN [see results] [see description]
  - Time-Step VPN
  - RRAS VPNs with PKI
- 3Com® Embedded Firewall (EFW) NIC Cards [see results] [see description]

The other special projects were single applications of tools and techniques to address unique situations. None were assessed.

Assessment of CINC 21 Products and Technology Categories

Decision-Focused Command and Control (DFC2)

The DFC2 technology category contains the assessments of presentation layer components, decision space management, decision summary, embedded chat, battle rhythm, and status rule management.[8]

[8] An assessment of the TCCC display that was a read-only web part on the DFC2 is located in the section, "Network Operations Tools and Services."

Decision Space Management

Assessment Events

- Assessment of Initial Decision Space Management Features (Nov 02) (Appendix D).
- Assessment of Status, Collaboration, NetOps, Decision Summary and Battle Rhythm Features (Nov 02) (Appendix E)
- Shadow Play at the Terminal Fury ’03 (TF03) Exercise (Dec 02) (Appendix F)
- Human–system interface analysis by human factors professionals (Appendix G)

Demonstration/training and hand-on usage of the technology were components of the sessions. User feedback and observation by assessors were the primary data collection methods used. In addition, human factors professionals performed human–system interface analyses in a laboratory environment.

Suitability

Positive Findings

E3. Synchronization of information management among key players (e.g., joint, coalition, inter-agency, and non-governmental organization partners) increased.

E4. Common understanding of plan progress improved.

F2. The sharing of inputs among the decision-makers increased.

H1. The currency of information was sufficient for the decision-makers' requirements.

H2. The completeness of the information was sufficient for decision-makers' requirements.

H3. The precision of the information was sufficient for decision-makers' requirements.

H6. The amount of relevant data available within the decision cycle was increased.

I8. CINC 21 technologies were accepted by the target users.

Remaining Challenges

A1. The accuracy of situation awareness and understanding among decision-makers was not increased.

B1. The time needed to collect, identify, and integrate information was not reduced.

I1. Staff's skills and knowledge were not better used

I4. Outcomes of distributed work processes were not satisfactory to the decision-makers.

Usability

Positive Findings

D1. Distributed members were able to exchange information quicker.

I2. Duplication of information and work was reduced.

J2. Conveyance of information on the display device platforms was supported.

L1. Time was reduced in establishing a collaborative framework *(display of data for collaborative efforts).*

Remaining Challenges

A2. Ability to scale and tailor visualization displays was not increased.

D2. The number of steps or procedures used to exchange information were not reduced.

J3. The information was not presented in a form that is usable by all distributed members.

I3. Workload was not reduced.

I5. The number of staff needed to perform the task was not reduced.

I6. CINC 21 technologies did not facilitate mission-relevant training.

Technical

Positive Findings

J1. Information transmittal attempts were successful.

M1. Server compatibility was not a problem.

M2. New applications and services operated within existing applications and services.

Remaining Challenges

A3. Decision support and knowledge management was not advanced.

General Findings

Positive Findings

- Users endorsed the integrated view of the decision space as valuable to attain and maintain situation awareness.
- The Decision Space Management is helpful in monitoring decision points and CCIRs.
- Detail and analyses available on drill-down is an efficient mechanism for exchange and presentation of information.

Remaining Challenges

- The presentation format interferes with users' ability to navigate efficiently within the decision space.
- The number of levels of relationships that are displayed for operations is inadequate.
- The functionality for creating and retrieving linked products is too limited.
- The refresh rate is too slow.
- The inability to save a configuration adds considerably to the user's workload.
- Access to applications is not stable.

Decision Summary

Assessment Events

- Assessment of Status, Collaboration, NetOps, Decision Summary, and Battle Rhythm Features (Nov 02) (Appendix E)
- Shadow Play at the Terminal Fury '03 (TF03) Exercise (Dec 02) (Appendix F)

Data were collected from operational users during two events. Demonstration/training and hand-on usage of the technology were components of the sessions. User feedback and observation by assessors were the primary data collection methods used.

Suitability

Positive Findings

F2. The sharing of inputs among the decision-makers increased.

Remaining Challenges

I8. Target users had reservations about the utility of the technology.

Usability

Positive Findings

--NONE--

Remaining Challenges

A2. Ability to scale and tailor visualization displays was not increased.

Technical

Positive Findings

--NONE--

Remaining Challenges

--NONE--

General Findings

Positive Findings

- Users endorsed the concept of a Decision Summary to provide decision-makers with relevant background information and to function as a briefing tool.

Remaining Challenges

- A mechanism is needed to display relationships between decision points and the ongoing decision development process.
- The display should have the capability to stand alone as a briefing tool.

Chat

Assessment Events

- Assessment of Status, Collaboration, NetOps, Decision Summary, and Battle Rhythm Features (Nov 02) (Appendix E)
- Shadow Play at the Terminal Fury '03 (TF03) Exercise (Dec 02) (Appendix F)

Data were collected from operational users during two events. Demonstration/training and hand-on usage of the technology were components of the sessions. User feedback and observation by assessors were the primary data collection methods used.

Suitability

Positive Findings

E3. Synchronization of information management among key players (e.g., joint, coalition, inter-agency, and non-governmental organizations) increased.

F2. The sharing of inputs among the decision-makers increased.

Remaining Challenges

I8. Target users had reservations about the utility of the technology.

Usability

Positive Findings

A2. Ability to scale and tailor visualization displays increased.

E1. The number of actions needed to coordinate between participants was reduced.

I6. CINC 21 technologies facilitated mission-relevant training.

Remaining Challenges

J2. Conveyance of information on the display device platforms was not supported.

Technical

Positive Findings

J1. Information transmittal attempts were successful.

M1. Server compatibility was not a problem.

Remaining Challenges

A3. Decision support and knowledge management was not advanced.

General Findings

Positive Findings

- Object-specific chat sessions are easy to use.
- The ability to "tear off" and retain multiple active chats received high ratings.

Remaining Challenges

- Time stamping on messages is needed.
- There is no alerting system for messages received.
- Users need the ability to resize chat windows.
- Individuals who are not currently logged on to DFC2 cannot be included in object-specific chat.

Battle Rhythm

Assessment Events

- Assessment of Status, Collaboration, NetOps, Decision Summary, and Battle Rhythm Features (Nov 02) (Appendix E)
- Shadow Play at the Terminal Fury '03 (TF03) Exercise (Dec 02) (Appendix F)

Data were collected from operational users during two events. Demonstration/training and hand-on usage of the technology were components of the sessions. User feedback and observation by assessors were the primary data collection methods used.

Suitability

Positive Findings

F2. The sharing of inputs among the decision-makers increased.

Remaining Challenges

H7. Faster synchronization of battle rhythms was not achieved.

I8. Target users had reservations about the utility of the technology.

Usability

Positive Findings

--NONE--

Remaining Challenges

A2. Ability to scale and tailor visualization displays was not increased.

Technical

Positive Findings

--NONE--

Remaining Challenges

--NONE--

General Findings

Positive Findings

- Users endorsed the concept of a Battle Rhythm as central to the DFC2 concept of operations.

Remaining Challenges

- There is insufficient fidelity to allow for filtering and display of specific activities.
- The tool must be able to display links between activities.
- Users need the ability to display multiple battle rhythms concurrently.

Status Rule Management

Assessment Events

- Assessment of Status, Collaboration, NetOps, Decision Summary, and Battle Rhythm Features (Nov 02) (Appendix E)
- Shadow Play at the Terminal Fury 03 (TF03) Exercise (Dec 02) (Appendix F)

Status Rule Management capabilities are provided in conjunction with the Decision Space Management component of DFC2. Data were collected from operational users during two events. Demonstration/training and hand-on usage of the technology were part of the sessions. User feedback and observation by assessors were the primary data collection methods used. In addition, human factors professionals performed a heuristic evaluation of its usability in a laboratory environment.

Suitability

Positive Findings

A1. The accuracy of situation awareness and understanding among decision-makers increased.

F2. The sharing of inputs among the decision-makers increased.

I8. CINC 21 technologies were accepted by the target users.

Remaining Challenges

--NONE--

Usability

Positive Findings

--NONE--

Remaining Challenges

A2. Scalability and the ability to tailor visualization displays was not increased.

I2. Duplication of information and work was not reduced.

I3. Workload was not reduced.

I6. CINC 21 technologies did not facilitate mission-relevant training.

J2. Conveyance of information on the display device platforms was not supported.

Technical

Positive Findings

J1. Information transmittal attempts were successful.

M1. Server compatibility was not a problem.

M2. New applications and services operated within existing applications and services.

Remaining Challenges

A3. Decision support and knowledge management was not advanced.

General Findings

Positive Findings

- Display of status attributes is predicted to increase situation awareness.
- Users endorsed the concept of displaying status attributes of decision points and CCIRs.

Remaining Challenges

- Status attributes and meanings are not standardized.
- Training and guidelines for use are needed.
- The refresh rate and the ability to save status parameters must be improved.
- The status display must be personalized so that users with different information needs can choose the level of detail to view.
- The status rule entry and editing processes are very cumbersome and time-consuming.

DFC2 Summary

Users rated the integrated view of the decision space provided by the Decision Space Management component of DFC2 as valuable. They estimate that it will help them to

maintain situation awareness of multiple events. They also felt it will be helpful to monitor specific decision points and CCIRs. The ability to drill down from the top-level display for more detailed information was judged to be an effective way to provide easy access to complete, relevant information. There are many usability concerns, however. The presentation format and users' ability to navigate must be improved. In addition, capabilities for creating and retrieving linked products must be improved.

When users saw a static display of the Decision Summary, they endorsed the concept of a feature that would provide a detailed synopsis of analyses, recommendations, and rationale about a decision point or other decision object. They judged that this type of feature could serve a valuable function as a briefing tool. However, when the Decision Summary was interactive, users provided very low ratings. The current implementation in DFC2 is not adequate to provide a decision-maker within the command with instant and comprehensive situation awareness. For example, there is not a clear relationship to decision points and the ongoing decision development process. DFC2 was assessed as incapable of standing alone as a briefing tool for a senior decision-maker.

When users saw a static display of the Battle Rhythm, they endorsed the concept of the feature as central to the concept of operations of DFC2. They were enthusiastic about the ability to display and compare multiple battle rhythms of multiple groups and to filter a battle rhythm display to show specified categories of activities. However, when the Battle Rhythm was interactive, users provided very low ratings. The current implementation in DFC2 does not provide adequate fidelity. Users judged it as not fully operative and as the least mature of the DFC2 technologies.

Users reported that most collaboration within the JOC is currently face-to-face. However, they could see high potential value of the DFC2 embedded Chat feature, especially if collaborative document editing was possible. DFC2 object-specific chat is easy to use, but lacks time stamp and alerting features. At present, user-selected views are not retained nor can the chat windows be resized. Users can now access NetMeeting to contact individuals who are not logged on to DFC2; however, the capability to include these individuals in the chat sessions was requested.

Users saw value in the ability provided by the DFC2 Status Rule Management to display status attributes of decision points and CCIRs. There was not consensus, however, about how much detail should be displayed. It was recognized that personalization of this feature is needed. Also needed are standardization of status attributes and their meanings. Guidelines for use are essential. The user must interact with numerous dialog boxes during several steps to enter or edit status attributes. This unwieldy procedure caused heavy workload and user dissatisfaction—the current Status Rule Management feature was ruled unacceptable because of this. The placement and naming of menu bars caused confusion; in addition, selecting pull-down menu items required precise mouse contact. The legibility and organization of the input and display fields was poor.

The *concept* of DFC2—applications that facilitate the definition, visualization, analysis, and management of decision-making activities associated with joint command and control—was well received by users. However, there is currently a lack of functioning links between component parts and between decision objects within component parts. The document linking and management services in their current stage of development do not fulfill users'

needs. In addition, concerns regarding the impact of DFC2 upon workload and organizational procedures remain. Therefore, Suitability is rated as YELLOW.

Usability problems were experienced throughout the assessment events, especially in areas of configuration retention and navigation. Excessive use of scrollbars limit users' ability to maneuver, and they present a confusing display. Many functions require numerous steps as well as interaction with multiple dialog boxes. Also, the use of screen real estate is less than optimal; web parts are often located partially or completely off the screen. As a result of these problems, Usability is rated as YELLOW.

A slow refresh rate and some instability of component parts occurred throughout the assessment events. These problems interfered with users as they attempted to input or access information. There were intermittent crashes of DFC2 during TF03; these crashes were associated with data losses. The Technical rating is YELLOW.

It has to be noted that DFC2 was in the very early stages of development during the JMUA. In some cases, it was only in a prototype form that lacked the richness of the overall concept. Thus, the JMUA is based on very limited data. As the concept matures and goes to full development, a follow-on evaluation can better assess the overall utility, usability, and ability to support the concept.

Decision Focused Command & Control	Suitability	Usability	Technical
	Y	Y	Y

Operational Packages

Common Operational Picture/Geo-Spatial Visualization

This technology category contains the assessments of AORB and FBV. Each technology is examined with regard to visual/presentation and content. Data regarding visualization are combined into COI-1, while information about content is in COI-2.

Area of Responsibility Basing

Assessment Events

- State of the AORB system (Jan 02) (Appendix H)

AORB feedback was collected from operational users on the state of the AORB system (as of January 2002) with regard to the Critical Infrastructure Protection (CIP) and Component Real Property (CRP). One user of the CIP and two users of the CRP were shown the AORB and asked to perform common tasks. Afterwards, each completed a questionnaire that addressed various issues concerning functional utility and interface usability.

Suitability

Positive Findings

A1. The accuracy of situation awareness and understanding among decision-makers increased.

A3. Decision support and knowledge management was advanced.

B1. The time needed to collect, identify, and integrate information was reduced.

B3. The time to display requested information decreased, so that additional time is available for analyzing decision options.

C1. Planners' satisfaction with the decision increased.

Remaining Challenges

C2. The degree to which decisions met organizational standards was not improved.

Usability

Positive Findings

D1. Distributed members were not able to exchange information quicker.

D2. The number of steps or procedures used to exchange information was reduced.

I3. Workload was reduced.

I5. The number of staff needed to perform the task was reduced.

J3. The information was presented in a form that was usable by all distributed members.

Remaining Challenges

--NONE--

Technical

Positive Findings

--NONE--

Remaining Challenges

H2. The completeness of the information was not sufficient for decision-makers' requirements.

General Findings

Positive Findings

- The tool provided a significant reduction in task time (from many hours to minutes).
- Fewer personnel were required to meet mission needs when using the tool.
- It was considered easy to learn and use.
- The tool enabled operators to visualize geo-spatial planning parameters.
- Users found the technology an improvement over current systems.

Remaining Challenges

- The tool lacks access to necessary operational data bases.
- Use of the tools requires a specialized web application.

AORB Summary

Suitability is rated as GREEN since AORB provided useful capabilities and improved efficiency. Users responded that this technology would help them meet their operational requirements. They were also able to navigate using the technology with minimal instruction. However, there are still many changes that should be made to the user interfaces to improve its usability. They are not issues that prevent users from ultimately accomplishing their tasks. Usability is, therefore, rated as GREEN. Unfortunately, incomplete data sources behind AORB prevent it from being used in a real operational setting. This major hurdle is responsible for the Technical rating of YELLOW.

Area of Responsibility Basing	Suitability	Usability	Technical
	G	G	Y

Fused Battlespace View

Assessment Events

- USSTRATCOM Consequence Management/Response Demonstration (Oct 02) (Appendix I)

  The FBV was part of the USSTRATCOM demonstration event in October 2002. Senior decision-makers where guided through an exercise, and then feedback on how the CINC 21 technologies (including FBV) were perceived to support and increment work processes in Consequence Management/Response. In addition, assessment team members had an opportunity to interview potential Action Officer (AO) users and to comment on the user interface.

Suitability

Positive Findings

B1. The time needed to collect, identify, and integrate information was reduced.

B3. The time to display requested information decreased, so that additional time is available for analyzing decision options.

C1. Planner's satisfaction with the decision option increased.

H1. The currency of information was sufficient for the decision-maker's requirements.

H3. The precision of information was sufficient for decision-makers requirements.

H6. The amount of relevant data available within the decision cycle was increased.

I8. CINC 21 technologies were accepted by the target users.

Remaining Challenges

A1. The accuracy of situation awareness and understanding among decision-makers did not increase.

H2. The completeness of the information was not sufficient for decision-makers' requirements.

Usability

Positive Findings

A2. Ability to scale and tailor visualization displays increased.

D2. The number of steps or procedures used to exchange information was reduced.

E1. The number of actions needed to coordinate between participants was reduced.

I3. Workload was reduced.

I5. The number of staff needed to perform the task reduced

I6. CINC 21 technologies facilitated mission-relevant training

I7. Watchstanders were able to relay information faster when managing routine theater activity.

L1. The time was reduced in establishing a collaborative framework.

Remaining Challenges

J2. Conveyance of information on the display device platforms was not supported.

J3. The information was not presented in a form that is usable by all distributed members.

Technical

Positive Findings

A3. Decision support and knowledge management was advanced.

Remaining Challenges

K5. The system did not provide a secure means for exchanging information among distributed users.

General Findings

Positive Findings

- The tool provides current information to all users.

- It decreases the number of steps and staff needed to develop and exchange information.
- Users found it to be easy to understand the content and to navigate through the workflow.
- Geo-spatial displays with drill-down capability aided situation awareness.
- Target users accepted the technology.

Remaining Challenges

- Insufficient drill-down capability was available.
- Users were unable to exchange information across security levels.
- Some user interface improvements are needed (font size, link colors, etc.).
- Procedural issues regarding dynamic updating need to be resolved.

FBV Summary

The FBV received high marks for Suitability as users were satisfied that their operational issues were addressed. When compared to how things are done today, the FBV could help users find information faster and with fewer personnel involved. Suitability is, therefore, rated as GREEN. Usability also received a GREEN rating because users were able to navigate the interface with very little instruction. At the time of the assessment, however, users wanted to access classified information, which the FBV was unable to provide. This lack of access to classified information results in a YELLOW rating for Technical.

Fused Battlespace View	Suitability	Usability	Technical
	G	G	Y

Briefing/Information Summary

This technology category contains the assessments for the Consequence Management Automated Brief and the COA Matrix.

Consequence Management Automated Brief

Consequence Management Automated Brief is a web-based briefing and information management tool that can be used to capture, archive, and organize text and graphics for presentation. It is intended to enhance the presentation of information by improving the display and access to consequence management related information.

Assessment Events

- Heuristic evaluation of interface features (Appendix J)
- LAO with civilian participants (Jul 02) (Appendix K)

The version of the Consequence Management tool evaluated in July 2002 was a web-based prototype intended to be a component of the Rapid Force Employment portal

developed for USPACOM by CINC 21. The usability focus was on viewing existing information rather than on generating new presentations. The two general goals were to measure (1) processing time as an indicator of workload and (2) usability and workload as perceived by the users. Human–computer interface evaluation helped identify the factors that affected processing time, usability, and workload.

Suitability

Positive Findings

I1. In general, the staff's skills and knowledge were better utilized.

Remaining Challenges

--NONE--

Usability

Positive Findings

J3. The information was presented in a form that is usable by all distributed members (except for the two home pages which were overly long and complex).

Remaining Challenges

I3. Workload was not always kept to a minimum.

Technical

Positive Findings

--NONE--

Remaining Challenges

A3. Decision support and knowledge management was not advanced.

General Findings

Positive Findings

- The tool provides a well-implemented structure for capturing information and for creating, managing, retrieving, and displaying presentations.
- Most pages (with the exception of the home pages) are clear, concise, comprehensive, and organized into well-structured categories.

Remaining Challenges

- Lengthy, complex home pages complicate navigation and information retrieval and impose excessive memory demands.
- Numerous bright colors on home pages distract users and hasten visual fatigue.
- Map graphics demand high bandwidth, resulting in long download times during peak periods.

- Improved error detection and correction, navigation aids, and online help are needed.

Consequence Management Automated Brief Summary

Consequence Management Automated Brief	Suitability	Usability	Technical
	G	Y	Y

Suitability was assigned a GREEN rating because, from the viewpoint of information access and management, this tool is capable of creating, managing, retrieving, and displaying information, which are the primary activities for which it was designed. In addition, the format, content, and layout of the majority of the Consequence Management (CM) pages are good. However, the two home pages are too long and contain too many links, creating problems in finding information and remembering where it is located. Because home pages are crucial for a tool's usability, the CM tool was given a YELLOW Usability rating.

The Technical aspects of this technology were not fully assessed, but indications are that response times are very slow with some of the graphics typically used in briefs. Therefore, Technical is given a YELLOW rating.

COA Matrix

Assessment Events

- USSTRATCOM Consequence Management/Response Demonstration (October 2002) (Appendix I)

  The COA Matrix was part of the USSTRATCOM demonstration event in October 2002. Senior decision-makers were guided through an exercise, and then feedback was collected regarding how the CINC 21 technologies (including the COA Matrix) were perceived to support work processes in Consequence Management/Response. In addition, potential AO users commented on the user interface during post-demonstration interviews.

Suitability

Positive Findings

A1. The accuracy of situation awareness and understanding among decision-makers was increased.

B1. The time needed to collect, identify, and integrate information was reduced.

B3. The time to display requested information decreased, so that additional time is available for analyzing decision options.

C1. The planners' satisfaction with the decision increased.

E2. The synchronization of decision tasks among key players improved.

H1. The currency of information was sufficient for the decision-maker's requirements.

H6. The amount of relevant data available within the decision cycle increased.

F2. The sharing of inputs among the decision-makers increased

F3. The ability to effectively present COAs was improved.

F4. The ability to evaluate alternative COAs was improved.

G2. Decision choices for crisis response were framed faster.

I8. CINC 21 technologies were accepted by the target users.

Remaining Challenges

H2. The completeness of the information was not sufficient for decision-makers' requirements.

H3. The precision of information was not sufficient for decision-makers requirements.

Usability

Positive Findings

A2. Ability to scale and tailor visualization displays increased.

D2. The number of steps or procedures used to exchange information was reduced.

E1. The number of actions needed to coordinate between participants was reduced.

I3. Workload was reduced.

I5. The number of staff needed to perform the task was reduced.

I6. CINC 21 technologies facilitated mission-relevant training.

I7. Watchstanders were able to relay information faster when managing routine theater activity.

J3. The information was presented in a form that was usable by all distributed members.

L1. The time was reduced in establishing a collaborative framework.

Remaining Challenges

J2. Conveyance of information on the display device platforms was not supported.

Technical

Positive Findings

A3. The decision support and knowledge management was advanced.

Remaining Challenges

H2. The completeness of the information was not sufficient

K5. The system did not provide a secure means for exchanging information among distributed users.

General Findings

Positive Findings

- Top-level decision information was aggregated in an understandable form.
- COA Matrix promotes side-by-side comparison of alternative COAs.
- The tool decreases the number of steps and staff needed to develop COAs.
- Users reported a high degree of satisfaction with the technology.

Remaining Challenges

- Some user interface improvements are needed (font size, colors, etc.).
- Easy access to business rules concerning color codes and terms is needed.
- Users need to be able to exchange information across security levels.

COA Matrix Summary

For Suitability and Usability, the COA Matrix received GREEN ratings. While it is certainly the case that some improvements are needed (colors are over-saturated, text font is too small and has too little contrast with background, access to business rules needs to be easier, etc.), users understood the color scheme and were quickly able to rank the various alternatives and select the preferred COA. Senior decision-makers liked the side-by-side comparisons and found the technology to be usable and an asset for them. As with many of the USSTRATCOM technologies, the issue of security and how to incorporate classified and unclassified into the technology was cause for concern. This resulted in a YELLOW rating for Technical.

COA Matrix	Suitability	Usability	Technical
	G	G	Y

Status Tracking and Linking

Status Tracking and Linking contains the assessments of Message Tracker, RFI Manager, and Team App. All three technologies were examined in terms of interface features and training requirements.

Message Tracker

The Message Tracker is a web-based document management system for organizing electronic messages that are sent between military staff members. It enhances the processing of orders by providing capabilities for capturing, filtering, archiving, and organizing messages. It allows users to group messages by operational categories and to link supporting messages to relevant events and CCIRs. It is intended to enhance the sharing of operationally relevant information and to make task assignments based on the messages.

Assessment Events

- Heuristic evaluation of interface features (Appendix L)

- LAO at USPACOM Joint Operations Center (JOC) (September 2002) (Appendix M)
- LAO with civilian participants (July 2002) (Appendix N)

Usability evaluations by human factors analysts supplemented performance and questionnaire data collected from six military and five civilian participants to assess the capabilities of the Message Tracker.

Suitability

Positive Findings

A1. The accuracy of situation awareness and understanding among decision-makers may increase.

F2. Sharing of inputs among the decision-makers increased.

H6. The amount of relevant data available within the decision cycle was predicted to increase.

Remaining Challenges

I1. The user's skills and knowledge were not always well-utilized.

I8. Message Tracker (in its current form) was not enthusiastically accepted by the target users.

Usability

Positive Findings

D1. Distributed members should be able to exchange information quicker.

I2. Duplication of information and work was reduced.

Remaining Challenges

I3. Workload was not appreciably reduced.

I6. Message Tracker did not always facilitate mission-relevant training.

J3. Information was not always presented in a form usable by all distributed members (feedback, refresh issues).

Technical

Positive Findings

M1. Server compatibility was not a problem.

M2. New applications and services operated within existing applications and services.

Remaining Challenges

A3. Decision support and knowledge management was not advanced.

General Findings

Positive Findings

- The tool links messages with significant events.
- It deals effectively with military message formats.
- Most web pages (except entry pages) were easy to understand and navigate.
- The tool enhances access to messages and information.

Remaining Challenges

- Online help for new users, and additional navigation tools for experienced users are lacking.
- The information structure does not facilitate navigation.
- Memory and workload demands are too high.
- The bright colors distract users and hasten visual fatigue.
- The interface cannot be customized to user tasks.
- Alerting, searching, display manipulation, and feedback mechanisms are inadequate.
- An excessive amount of practice is currently needed to reach proficiency.
- Refresh rate may be too slow for operational use.

Message Tracker Summary

The Message Tracker is effective at linking messages to significant events and increasing staff's access to information, which are all important suitability features. Therefore, Suitability is rated GREEN. Improving interface features, error prevention and detection, online help, and search capabilities can enhance usability. However, none of these shortcomings prevent users from accomplishing their tasks, and Usability is rated as YELLOW. The Technical rating is GREEN, since a slow refresh rate was the only technical problem encountered. However, use in an actual operational environment is needed for an ample assessment of technical capabilities.

Message Tracker	Suitability	Usability	Technical
	G	Y	G

RFI Manager

The RFI Manager is a web-based document management system for handling formal requests for information within and between military staffs. Currently, this is a CINC 21 stand-alone application. It is not linked to the knowledge core at this time. It is intended to enhance the processing of RFIs by improving the display of RFIs and the management of the RFI database. A component of the RFI Manager system is information management via tasking of registered users by the manager. At USPACOM headquarters, it uses local databases and web forms that link to the local database. This combination allows for a local capability to track requests and identify due dates, status, and responsible individual/organization. The

tool has been used extensively at the Joint Task Force headquarters by III MEF and COMSEVENTHFLT.

Assessment Events

- LAO at USPACOM JOC (September 2002) (Appendix O)
- LAO with civilian participants (July 2002) (Appendix P)
- Special assessments by III MEF in Cobra Gold 02 and in Operation Bevel Express 02.

During September 2002, six individuals in the JOC at USPACOM received training on the RFI Manager and subsequently completed a series of tasks using it. Assessment measures consisted of direct observation of performance as well as user responses to survey and interview items. A similar data collection effort was also conducted at the Space and Naval Warfare Systems Center, San Diego (SSC San Diego) with five civilian participants. A heuristic evaluation by human factors professionals that examined the usability characteristics of the RFI Manager was included in the July 2002 assessment. III MEF and Commander Seventh Fleet (COMSEVENTHFLT) have used it in operational exercises.

Suitability

Positive Findings

F2. The sharing of inputs among the decision-makers increased.

Remaining Challenges

H6. The amount of relevant data available within the decision cycle did not significantly increase.

I1. Staff's skills and knowledge were not better utilized.

I8. The RFI Manager was not readily accepted by the target users at USPACOM.

Usability

Positive Findings

--NONE--

Remaining Challenges

D1.Distributed members were not able to exchange information quicker.

I2. Duplication of information and work was not reduced.

I3. Workload was not reduced.

I6. Did not facilitate mission-relevant training.

J3. Information was not presented in a form that was usable by all distributed members (in terms of legibility and feedback).

Technical

Positive Findings

M1. Server compatibility was not a problem.

M2. New applications and services operated within existing applications and services.

Remaining Challenges

A3. Decision support and knowledge management was not advanced.

General Findings

Positive Findings

- The tool generates and manages RFIs and links them to CCIRs.
- It provides search and automated display and sorting capabilities.

Remaining Challenges

- Many interface features were inconsistent with applicable human–computer interface standards.
- Users cannot determine the status of RFIs without opening each RFI.
- The tool does not adequately support multiple user categories (Anonymous User, Registered User, Manager).
- It is unavailable to personnel outside of the JOC.
- It needs improved navigation aids, feedback, searching, error prevention, alerting, online help, screen layout, and documentation.
- A user-customizable display is needed.
- Substantial training and practice are needed to gain proficiency.
- The tool may impose excessive workload on personnel involved in message management.
- The refresh rate may be too slow for operational use.

RFI Manager Summary

While the concept of the RFI Manager was endorsed, assessments at USPACOM indicated that its current stand-alone status limits its usefulness. In addition, user management issues have not been adequately resolved. III MEF suggested that dedicated staff would be necessary to use the tool effectively. Therefore, the combined Suitability rating across COCOM and Joint Task Force (JTF) levels is YELLOW. Assessments at USPACOM and SSC San Diego revealed that the RFI Manager had significant problems with usability and will require redesigns to become an effective tool. Its deficiencies include (1) problems in determining the status of unopened RFIs, (2) inconsistent interface features, and (3) inadequate user support. III MEF reported that RFI Manager was used in operational venues and suggested capability upgrades that would enhance its ease of use. The composite rating for Usability across COCOM and JTF levels is YELLOW. The Technical component is rated GREEN, as the only problem encountered during these assessments was a refresh rate that may be inadequate for operational use.

RFI Manager	Suitability	Usability	Technical
	Y	Y	G

TeamApp

Team Application (TeamApp) is a special-purpose, web-based application developed at USPACOM for use by COCOM and CJTF staff. It provides point-to-point and multi-user file transfer and sharing functionality, as well as information push–pull from secure and public websites.

Assessment Events

- Kernel Blitz Experimental KB(X) (Jun 01). (Appendix R)

TeamApp was evaluated as part of the CINC 21 demonstration during Kernel Blitz Experimental KB(X) in June 2001. Performance and questionnaire data were collected to assess the capabilities of TeamApp. A total of 27 participants provided input about TeamApp, which included USPACOM staff, COMTHIRDFLT personnel, and members of 1 MEF.

Suitability

Positive Findings

A4. The consistency of situation awareness and understanding among decision-makers increased.

I4. The outcomes of distributed work processes were satisfactory to the decision-makers.

I8. TeamApp was accepted by the target users, who rated it favorably in terms of utility, power, and ability to order information.

Remaining Challenges

B3. The time to display requested information was not decreased, so that additional time was not available for analyzing decision options.

Usability

Positive Findings

I6. TeamApp facilitated mission-relevant training.

J2. Conveyance of information on the display device platforms was supported.

Remaining Challenges

--NONE--

Technical

Positive Findings

--NONE--

Remaining Challenges

K1. Controllers had difficulty viewing and monitoring network operations (due to slow download times).

General Findings

Positive Findings

- It was useful for creating and modifying briefings and for responding to CCIRs.
- Users found it to be an effective way to access the web, especially for information push–pull.
- The interface features support the intended functions.

Remaining Challenges

- Viewing times for briefings and reports are too slow. (Slow download times when bandwidth is limited.)

TeamApp Summary

Suitability receives a rating of GREEN. It is well-suited to achieve its design goals of file transfer, creating and sharing briefings, responding to CCIRs, and information push–pull from secure and public websites. It may also be instrumental in reducing manpower requirements. Usability also receives a rating of GREEN. Users found it easy to insert documents into web pages and to communicate with each other during the planning process. User ratings of TeamApp indicated that it was easy to use, potentially very powerful, and helpful for organizing data. Technical is assigned a rating of YELLOW due to the slow download times under conditions of limited bandwidth, which was the only negative aspect identified for TeamApp.

TeamApp	Suitability	Usability	Technical
	G	G	Y

Time-Based Event Management

This technology group consists of the TMS and the Master Calendar.

Assessment Events

The same limited assessment opportunity events (Appendix S and Appendix T) were used to collect data for technologies in this group. Data were gathered from each user in three phases: (1) an interview in which users discussed their likes and dislikes and how they used each technology; (2) a questionnaire; and (3) a heuristic evaluation based on the Style Guide.

Task Management System

Suitability

Positive Findings

E4. The common understanding of plan progress improved.

H2. The completeness of the information was sufficient for decision-makers' requirements.

H3. The precision of the information was sufficient for decision-makers' requirements.

H4. The correctness of the information was sufficient for the decision-makers' requirements.

B1. This technology decreased the time needed to collect, identify, and integrate information.

Remaining Challenges

E4. This technology did not help make clear the dependencies between tasks.

I4. This technology did not increase satisfaction with work processes.

I8. This technology was not an improvement to work processes.

Usability

Positive Findings

D1. Distributed members exchanged information quicker.

D2. This technology helped to decrease the number of steps or procedures used to exchange information.

E1. This technology decreased the number of actions needed to coordinate between participants.

I3. This technology helped to decrease workload.

J3. The displayed information was legible.

Remaining Challenges

I5. This technology did not help to decrease the number of staff needed to perform the task.

I6. It was not easy to learn how to use this technology.

J2. The conveyance of information on the display device platforms was not supported.

Technical

Positive Findings

Currently in operation.

Remaining Challenges

--NONE--

General Findings

Positive Findings

- This tool helped to facilitate the exchange of information.
- The new version of the tool is more usable than the system that users used at time of assessment.

Remaining Challenges

- Users reported that adequate training was not given, and that this lack of training is responsible for others using the system either incorrectly or not at all.
- The e-mail-based system is hard to manage short-term processes, because users must be at their computer to receive a task notification. E-mail notification alerting can be insufficient when compared to physically finding someone and giving them a task.

TMS Summary

In the questions that probed Suitability, many user responses were divided. They were split on issues such as overall satisfaction. Based on questions raised during the interview process regarding TMS, Suitability receives a rating of YELLOW. There are some procedural concerns regarding who is using the system and how they are using it. Several of the items that pertained to usability were rated as less-than-favorable (see Remaining Challenges above). However, users had not yet seen the new version of TMS, which was substantially improved. A heuristic evaluation conducted on this version accounts for the GREEN rating for Usability. No technical problems were encountered, and the Technical rating is GREEN.

Task Management System	Suitability	Usability	Technical
	Y	G	G

Master Calendar

Suitability

Positive Findings

A1. This technology helped improve accuracy in understanding the operational situation.

B1. This technology decreased the time needed to collect, identify, and integrate information.

F1. Collaboration improved the quality of the plan that was produced.

H1. The currency of information was sufficient for the decision-makers' requirements.

H2. The completeness of the information was sufficient for decision-makers' requirements.

H3. The precision of the information was sufficient for decision-makers' requirements.

H4. The correctness of the information was sufficient for the decision-makers' requirements.

I4. This technology increased user satisfaction with work process.

I8. This technology is an improvement to the work process.

Remaining Challenges

E4. The common understanding of plan progress was not improved.

Usability

Positive Findings

D1. Distributed members were able to exchange information quicker.

D2. This technology helped to decrease the number of steps or procedures used to exchange information.

E1. This technology decreased the number of actions needed to coordinate between participants.

I6. It was easy to learn how to use this technology.

J3. The displayed information is legible.

Remaining Challenges

I3. This technology did not help to decrease workload.

I5. This technology did not help to decrease the number of staff needed to perform the task.

J2. The conveyance of information on the display device platforms was not supported.

Technical

Positive Findings

This product is currently in operation.

Remaining Challenges

–NONE–

General Findings

Positive Findings

- Target users accepted Master Calendar.
- Users found the interface to be simple to use.
- Master Calendar helped facilitate the exchange of information.
- Master Calendar provides current information to all users.

Remaining Challenges

- More options are needed for customizing the calendar display.

Master Calendar Summary

Master Calendar met the needs of its users and was very simple to use. Although some improvement could be made to offer more flexible calendar configurations, it firmly deserves GREEN ratings across the board for Suitability, Usability, and Technical.

Master Calendar	Suitability	Usability	Technical
	G	G	G

JWID Coalition Interoperability Service (COINS)

The Operational Package, JWID COINS, is an instantiation of Knowledge Management, but it was developed as an application to specifically support the Joint Warfighter Interoperability Demonstration in 2002.

Assessment Events

- Joint Warrior Interoperability Demonstration (JWID) 2002 (Appendix U)

Data were collected from distributed operational users in four coalition countries (Australia, Canada, the United Kingdom, and the United States) as they used COINS on the JWID Administrative Portal to access information from separate national databases during JWID 2002. Users also completed questionnaire items that addressed various issues concerning functional utility and interface usability. In addition, human factors professionals performed a heuristic evaluation of its usability in a laboratory environment.

Suitability

Positive Findings

B3. The time to display requested information decreased, so that additional time is available for analyzing decision options.

H1. The currency of information was sufficient for the decision-makers' requirements.

I8. CINC 21 technologies were accepted by the target users.

E3. Synchronization of information management among key players (e.g., joint, coalition, inter-agency, and non-governmental organization partners) increased.

H6. The amount of relevant data available within the decision cycle was increased.

Remaining Challenges

B1. The time needed to collect, identify, and integrate information was not reduced.

I2. Duplication of information and work was not reduced.

Usability

Positive Findings

A2. Ability to scale and tailor visualization displays increased.

I3. Workload was reduced.

Remaining Challenges

I6. CINC 21 technologies did not facilitate mission-relevant training.

J3. The information was not presented in a usable form for all distributed members.

Technical

Positive Findings

A3. Decision support and knowledge management was advanced.

J1. Information transmittal attempts were successful.

K2. The controllers had central access to coalition non-combatant evacuation operation information.

Remaining Challenges

--NONE--

General Findings

Positive Findings

- Current information could be accessed and displayed quickly from shared databases.
- Synchronization of information management was achieved.

Remaining Challenges

- Currently, entering multiple information requests requires duplication of effort.
- Data cannot be seamlessly transferred between applications.
- The information display format negatively impacts readability.
- The amount of user feedback provided by the system is inadequate.

JWID COINS Summary

Distributed coalition partners saw high value in the ability to access information from separate shared databases. COINS allowed users to pinpoint relevant data and to synchronize information management. The Suitability rating is GREEN. The search process was cumbersome due to the design of the input fields and the need to duplicate efforts to conduct multiple single searches. The results display was not easily readable due to poor design of the format. Users were unable to seamlessly transfer data to other applications, and had to spend much time cutting and pasting. Due to these issues, Usability is rated as

YELLOW. The availability of COINS and accessibility of data was high. The Technical rating is GREEN.

JWID COINS	Suitability	Usability	Technical
	G	Y	G

Displays

Group Displays

The Group Displays contain assessments of the USSTRATCOM Knowledge Wall and the USPACOM Video Wall. The Video Wall data, however, are very limited. More importantly, the Video Wall was an early implementation of a large-screen display. It has very limited utility and is not a candidate for transition.

USPACOM Video Wall (Standard Resolution Large Screen Display)

Assessment Events

- Build 1 Technologies Assessment Report (October 2000) (Appendix V)
- Limited HCI analysis

Suitability

Positive Findings

--NONE--

Remaining Challenges

A1. The accuracy of situation awareness and understanding among decision-makers was not increased.

H2. The completeness of the information was not sufficient.

Usability

Positive Findings

D2. The number of steps or procedures used to exchange information was reduced.

J2. Conveyance of information on the display device platforms was supported.

J3. Information was presented in a form that was usable by all distributed members.

Remaining Challenges

A2. Ability to scale and tailor visualization displays was not increased.

D2. The number of steps or procedures used to exchange information was not reduced.

I3. Workload was not reduced.

I7. Watchstanders were not able to relay information faster when managing routine theater activity.

Technical

Positive Findings

--NONE--

Remaining Challenges

K5. The system did not provide a secure means for exchanging information among distributed users.

General Findings

Positive Findings

- The Video Wall provided a focal point for group viewing and collaboration.
- Target users accepted this technology.

Remaining Challenges

- The display needs to be designed to scale properly.
- It increased the potential for information overload.
- Text size and content layout needs to be designed to support group viewing and attention management.
- Physical room layout and ambient lighting negatively impact visibility of the Video Wall.

USPACOM Video Wall Summary

The USPACOM Video Wall represents early large-screen display technology. It only provides three independent viewing screens. The input to these screens can be either digital or video. In addition, although it is currently used to provide support during command briefings, the Video Wall is not planned for continued use by USPACOM. Thus, any rating would be inappropriate.

PACOM Video Wall	Suitability	Usability	Technical
			

USSTRATCOM Knowledge Wall (High-Resolution, Large-Screen Display)

Assessment Events

- Limited Assessment Opportunity to determine the legibility of various text sizes at various fixed viewing distances (Appendix X)
- Interviews of expert Knowledge Wall operators (producers)

- USSTRATCOM Consequence Management/Response Demonstration (October 2002) (Appendix I)

Suitability

Positive Findings

A1. The accuracy of situation awareness and understanding among decision-makers was increased.

B1. The time needed to collect, identify, and integrate information was reduced.

B3. The time to display requested information decreased, so that additional time is available for analyzing decision options.

H2. The completeness of the information was sufficient for decision-makers' requirements.

H6. The amount of relevant data available within the decision cycle increased.

I8. CINC 21 technologies were accepted by the target users.

Remaining Challenges

--NONE--

Usability

Positive Findings

A2. Ability to scale and tailor visualization displays increased.

D2. The number of steps or procedures used to exchange information was reduced.

I3. Workload was reduced.

I5. The number of staff needed to perform the task was reduced.

I7. Watchstanders were able to relay information faster when managing routine theater activity.

J2. Conveyance of information on the display device platforms was supported.

J3. Information was presented in a form that was usable by all distributed members.

L1. The time was reduced in establishing a collaborative framework.

Remaining Challenges

--NONE--

Technical

Positive Findings

A3. The decision support and knowledge management was advanced.

J1. Information transmittal attempts were successful.

Remaining Challenges

H2. The completeness of the information was not sufficient

K5. The system did not provide a secure means for exchanging information among distributed users.

General Findings

Positive Findings

- This display gave users the "big picture" view, increasing situation awareness.
- It provided a focal point for group viewing and collaboration.
- Excellent visibility of text and graphics was noted from most viewing positions.
- Target users accepted the technology.

Remaining Challenges

- The display needs to be designed to scale properly to Knowledge Wall.
- There is increased potential for information overload.
- Text size and content layout needs to be designed to support group viewing and attention management.
- Physical room layout and ambient lighting could negatively impact Knowledge Wall visibility.

USSTRATCOM Knowledge Wall Summary

The Knowledge Wall has been in use at USSTRATCOM for approximately 1 year, and they have had time to discover many pros and cons regarding its use in an operational setting. Having such a large screen, there are many areas of concern regarding interface layout, room layout, information overload, and attention management. However, at the USSTRATCOM demonstration in October 2002, participants commented that the Knowledge Wall improved understanding of the operational situation and that it was easy to follow the briefings. These high user endorsements, coupled with a lack of technical problems, accounts for GREEN ratings in Suitability, Usability, and Technical.

USSTRATCOM Knowledge Wall	Suitability	Usability	Technical
	G	G	G

Workstation Displays

The Workstation Displays technology category consists of multi-screen displays. Workstation Displays can be implemented either as separate monitors placed side-by-side or as a single multi-screen display, such as the Panoram PV290.

Multiple Side-by-Side Flat Panel Monitors

Assessment Events

- Human–system interface analysis
- Field observations and user feedback

Suitability

Positive Findings

A1. The accuracy of situation awareness and understanding among decision-makers was increased.

B1. The time needed to collect, identify, and integrate information was reduced.

B3. The time to display requested information decreased, so that additional time is available for analyzing decision options.

H2. The completeness of the information was sufficient for decision-makers' requirements.

H6. The amount of relevant data available within the decision cycle increased.

I8. CINC 21 technologies were accepted by the target users.

Remaining Challenges

--NONE--

Usability

Positive Findings

A2. Ability to scale and tailor visualization displays increased.

I3. Workload was reduced.

I5. The number of staff needed to perform the task was reduced.

J2. Conveyance of information on the display device platforms was supported.

J3. The information was presented in a form that was usable by all distributed members.

Remaining Challenges

--NONE--

Technical

Positive Findings

A3. The decision support and knowledge management was advanced.

J1. Information transmittal attempts were successful.

Remaining Challenges

--NONE--

General Findings

Positive Findings

- The display configuration possesses substantial technical capability to support concurrent processes.
- It affords increased situation awareness and integration of diverse information.
- The greater screen space improves the user's ability to detect critical events and changes.
- It enables easier access to diverse information sources and software applications.
- It supports faster responses to multiple collaboration (chat) sessions.

Remaining Challenges

- It requires careful layout of workspaces and applications onto screens.
- Video performance (speed) may be degraded when highly dynamic applications are used.

Multiple Side-by-Side, Flat-Panel Monitors

With ergonomically acceptable setup and adequate technical support (e.g., appropriate video cards), the multiple side-by-side flat-panel monitors provide many benefits to the user at a relatively low cost. This type of workstation display earns GREEN ratings for Suitability, Usability, and Technical.

Multiple Side-by-Side Flat Panel Monitors	Suitability	Usability	Technical
	G	G	G

PV290 Multi-screen Desktop Display

The Panoram PV290 DSK desktop tri-panel LCD display is an industrial-grade display with 12 source inputs, external USB input switching, and built-in, multi-channel audio. The overall image size across its three equal-sized screens (18.1 inches diagonal) is 43.5 inches x 11.5 inches, making it approximately equivalent to three 19-inch monitors. The resolution of each screen is 1280 x 1024 (overall resolution = 3840 x 1024).

The PV290 is an example of the type of multi-screen monitor that may be suitable for military information technology and command and control tasks. However, the information architecture of CINC 21 (specifically DFC2) did not utilize the full capabilities of the PV290 (e.g., simultaneous handling of inputs from up to six computers and three monitors that provided six VGA screens and three NTSC).

Assessment Event

An ergonomic evaluation of the PV290 was conducted using the ergonomic guidelines and standards contained in "Ergonomic Guidelines for Multiple Monitor Workstations."[9] Because no actual PV290 display was available for this evaluation, this assessment was based on the descriptions, specifications, and graphical images of the PV290 found on its web page (http://www.panoramtech.com/products/pv290.html). Although there are inherent limitations in not directly examining an actual PV290, it is still possible to assess its overall ergonomic characteristics relative to CINC 21 requirements. This ergonomic assessment was supplemented with informal comments provided by PV290 users at USPACOM and USSTRATCOM.

Overall, the PV290 affords the same benefits and challenges as noted previously for the multiple, side-by-side flat panel monitors. Since the PV290 provided three screens on which users could display a variety of task-relevant information, it makes it easier for users to detect changes in critical events, access and integrate diverse information sources, and maintain situation awareness. On the other hand, some effort is needed with any multi-monitor workstation to layout the information on the screens properly and to train users to manipulate the screen configurations. The following are additional issues, specific to the PV290.

General Findings

Positive Findings

- The specifications of the PV290 indicate that it satisfies the single-user ergonomic guidelines for monitor display properties, such as screen luminance, contrast, color, and luminance uniformity.
- The three screens are separated by a 0.625-inch wide bezel, enabling it to present a more seamless image than separate, conventional monitors placed side-by-side.
- The total lateral viewing angle of the three screens is less than 190 degrees, in accordance with ergonomic guidelines.
- The three screens are approximately equidistant from the viewer when seated at a recommended distance from the center screen (25–30 inches).
- Because the three screens are approximately equidistant from the viewer, moving from one screen to another can be done with little effect on visual accommodation and convergence, consistent with ergonomic guidelines.

Remaining Challenges

- The non-adjustable viewing angles make it difficult for more than one person to view the screens simultaneously.
- The dimensions of the PV290 (height: 19 inches, width: 43 inches, depth: 22 inches) combine with its canted peripheral screens to require a large desktop

[9] Pacific Science & Engineering Group. 2000. *Ergonomic Guidelines for Multiple Monitor Workstations.* San Diego, CA.

footprint. This footprint may limit the available working surface for papers, etc.

- Sub-optimal positioning of the PV290 due to its large footprint could result in glare, diminished screen contrast, and specular reflectance.
- The PV290 is expensive compared to the cost of three conventional monitors.
- The users' tasks and work processes do not currently require the full capability of the PV290. Job redesign and training analysis are needed to determine how its capabilities could be used in an operational work setting. If, however, expanded work processes are determined to be unnecessary, then the PV290 capability would be assessed as excessive.
- Considerable specialized maintenance by the manufacturer is needed, and quick access to unique replacement parts is necessary in a military setting. Transfer of some of these repair and maintenance functions to onsite staff would be highly beneficial in terms of time and cost.

PV290 Multi-Screen Desktop Display Summary

The PV290 satisfies most ergonomic guidelines for desktop displays viewed by a single user who is seated in the recommended viewing position. It is less satisfactory for multiple simultaneous viewers, not all of who will be able to assume acceptable viewing positions in relation to the three LCD screens. Given the high cost of a PV290 and the fact that present CINC 21 technologies do not take full advantage of the PV290's capabilities (e.g., handling simultaneous inputs from multiple computers and monitors), its use is not currently recommended for CINC 21 activities.

PV290 Multi-Screen Desktop Display	Suitability	Usability	Technical
	G	G	Y

Collaboration

This section contains the assessments of the primary collaborative services that have been provided by the CINC 21 core capabilities or have been incorporated as components of CINC 21 technologies. Most of these are provided by the Defense Collaboration Tool Set (DCTS) or its components, NetMeeting and the Distributed Collaborative Planning and Conferencing (DCP) feature of the JWID Administration Portal. Due to the non-independent nature of these tools, data from these technology sets are combined in this section. In addition, data from IWS, which is used extensively at USPACOM, are included. The IWS data, however, were limited.

Assessment Events

- Build 1 Technologies Assessment Report (October 2000) (Appendix V)
- Kernel Blitz Experimental (KB(X) (Oct 01) (Appendix R)
- CINC 21 Training (March 202) (Appendix W)
- Joint Warrior Interoperability Demonstration (May 2002) (Appendix U)

- USSTRATCOM Consequence Management/Response Demonstration (October 2002) (Appendix I)
- Special assessment by J21 USPACOM (February 2003)

Data were collected from operational users during multiple events. Demonstration/ training and hand-on usage of the technology were components of the sessions. User feedback and observation by assessors were the primary data collection methods used.

Suitability

Positive Findings

A1. The accuracy of situation awareness and understanding among decision-makers increased.

A4. The consistency of situation awareness and understanding among decision-makers increased.

B3. The time to display requested information decreased, so that additional time was available for analyzing decision options.

C1. Planners' satisfaction with the decision increased.

E2. Synchronization of decision tasks among key players (e.g. joint, coalition, inter-agency, and non-governmental organization partners) improved.

E3. Synchronization of information management among key players (e.g. joint, coalition, inter-agency, and non-governmental organization partners) increased.

E4. Common understanding of plan progress improved.

E6. Team actions were better synchronized by collaboration (IWS only).

F2. The sharing of inputs among the decision-makers increased.

G1. The time to develop of mission and intent was reduced.

I2. Duplication of information and work was reduced (IWS only).

I3. Workload was reduced (IWS only).

I4. Outcomes of distributed work processes were satisfactory to the decision-makers.

I8. CINC 21 technologies were accepted by the target users.

Remaining Challenges

B2. Time availability to analyze the information and determine the best COA was not reduced.

I5. The number of staff needed to perform the task was not reduced (IWS only).

L2. The response time to decision-makers' questions was not decreased.

Usability

Positive Findings

D1. Distributed members exchanged information quicker.

D2. The number of steps or procedures used to exchange information was reduced.

E1. The number of actions needed to coordinate between participants was reduced.

J3. The information was presented in a form that is usable by all distributed members.

Remaining Challenges

A2. Ability to scale and tailor visualization displays was not increased.

I6. CINC 21 technologies did not facilitate mission-relevant training.

Technical

Positive Findings

K5. The system provided a secure means for exchanging information among distributed users.

M1. Server compatibility was not a problem (IWS only).

Remaining Challenges

A3. Decision support and knowledge management was not advanced.

J1. Information transmittal attempts were not successful

J4. Conveyance of information was not facilitated.

K2. The controllers often did not have central access to coalition non-combatant evacuation operation information.

M1. Server compatibility was a problem.

M2. New applications and services did not operate within existing applications and services.

General Findings

Positive Findings

- Shared applications supported interaction among users.
- Collaborative sessions between distributed users led to increased situation awareness.
- Collaborative tools are considered useful when consistently available.
- Collaborative sessions facilitate efficient information exchange.
- Secure collaboration can be provided for up to 120 participants (IWS only).

Remaining Challenges

- Stable connectivity must be provided.
- Improved user feedback is needed in areas of login, active/available sessions, active members, and status of audio/video.
- Training and operating procedures/business rules are needed for efficient use of collaboration tools.

Collaboration Summary

Distributed users found high value in sharing documents, briefs, and desktops. They considered that collaboration tools provide an efficient mechanism for the exchange of information. Users judged that collaborative sessions led to increased situation awareness. Suitability summary is rated as GREEN.

However, chat often became the de facto collaboration tool due to bandwidth restrictions. Audio was preferred when available; video was often unstable and considered by many users to be redundant and unnecessary. The status of audio–video and of session membership was frequently difficult to discern with the DCTS technologies. Feedback to the user regarding success of data transmittals was not always adequate. In addition, several areas of the IWS computer interface were identified as requiring modification to improve ease of use. Other impediments to use are lack of training, lack of business rules, and lack of interoperability between collaboration systems. Usability is rated as YELLOW.

The inability of DCTS technologies to provide stable connectivity is an obstacle toward reaching the goal of synchronizing decision-making and information management among distributed users. In addition to the technical aspects, personnel's confidence and willingness to use these collaboration tools is negatively impacted. However, the ability to provide stable connectivity was demonstrated with IWS in actual operational use. Therefore, the Technical summary indication for the CINC 21 collaborative services technology category is YELLOW.

Collaboration	Suitability	Usability	Technical
	G	Y	Y

Network Operations Tools and Services

The network operations aggregate several commercial applications through the CINC 21 knowledge core. The applications are ingested in the knowledge core with their XML tags. This information is then aggregated and displayed as tables (in near real-time) via business rules. The presentation is a matrix with drill-down capability that presents the state of operational servers and networks. Network operations were supported by monitoring and information assurance tools. Assessment of the Network Operations suite is provided below. Separate assessments are also provided for the TCCC Status Grid, with a focus on the output of the display, and for BMC Patrol, as this tool has been installed and fielded independently.

Theater C4ISR Status Grid

This grid is a graphic display, broken down by theater organization and type of resource. It displays a rollup of the Remedy trouble tickets assigned to each location and resource. A drill-down capability allows the operator to see the actual ticket.

Assessment Events

Assessment was addressed during the Build 1 Technologies Assessment (Appendix V), the JJWID 2002 (Appendix U), and the assessment of the CINC 21 Technology DFC2 Interface (Appendix E and Appendix F). A depiction of the TCCC Status Grid was available during JWID and USPACOM assessments, but viewing the operational status of networks was not possible as there was no active link to the display. Changes to the display were accomplished manually. However, comments by representative users about this display were collected. Assessment was also provided by users in the TCCC (February 2003). These data are integrated into the following lists.

Suitability

Positive Findings

- H1 Information was current.
- H2. Information was relevant.
- H3. Information was precise.
- H4. Information was accurate.

Remaining Challenges

- B1. Did not decrease time needed to collect, identify, and integrate information.
- I1. Did not fit well with current work processes.
- I4. Did not increase satisfaction with work processes.

Usability

Positive Findings

- D1. Facilitated information exchange.
- J2. It was easy to change layout.
- J2. It was easy to change content.
- J3. Information was legible.

Remaining Challenges

- D2. Did not decrease number of steps or procedures used to exchange information.
- I3. Did not decrease workload.
- I6. Time to learn the technology would be excessive.

Technical

Positive Findings

J1. Information transmittal attempts were successful.

Remaining Challenges

K1. Controllers were not able to increase their ability to view and monitor network operations.

Theater C4ISR Status Grid Summary

Provision of information by the grid was highly rated. However, users reported no increase in saving time [SRB1]to share the information; TCCC user acceptance was mixed. Users in the JOC reported that the display would have limited value for them. Suitability rates a YELLOW. Workload was not decreased for users in the TCCC. Users in the JOC estimated a steep learning curve for the display to be useful. Usability is rated YELLOW. TCCC users reported that information was successfully transmitted via the grid, but its use did not increase their ability to view and monitor network operations, nor did it increase their confidence in system security. Technical, therefore, rates a YELLOW. The composite scores for TCCC Status Grid are shown below.

Theater C4ISR Status Grid	Suitability	Usability	Technical
	Y	Y	Y

Network Operations (NetOps) Status Monitoring

The NetOps suite provides real-time status of network resources and services across the theater using a set of portal based visualizations viewable from within a web browser. These visualizations are designed to help the TCCC Watch Commander rapidly determine COCOM-level mission impact of network and resource outages from across the entire theater.

The visualizations are divided into two distinct categories:

- Information Assurance
  - Derives their displays from data generated by the AAIDE system.
  - Leverages AIDE System's ability to collect and normalize intrusion events.
  - Includes the EICS, EPC, and Link Analysis tools.
- Network Monitoring
  - Derives their displays from data generated by the Remedy Trouble Ticket system using a specifically formatted trouble ticket.
  - Uses Remedy to drive displays and to integrate with other system tools.
  - Includes the TCCC Status Grid and Automated Capability Brief tools.

The goals for providing these products are as follows:

- Improve the TCCC Watch Officer's ability to provide up-to-date mission impact assessment to the Command Center.

- Provide the TCCC Watch Officer the ability to take twice-daily snapshots of the entire theater's network resources status in the form of an editable, navigable HTML brief. These briefs are shown to the senior decision-makers and archived for future reference.
- Provide the Command Center with high-level, near-real-time status of theater network resources in the form of automated network operations CCIR status.

Fielding

The NetOps suite is implemented as a web application and is currently used by the USPACOM TCCC in its stand-alone form.

The NetOps suite of tools has come from an evolutionary process of step-wise refinement. There exists no requirements documentation describing the desired ultimate functionality. This process allows for rapid application development but also injects a great amount of change into the software engineering process. There exists a tradeoff between flexibility, environmental requirements, and the time needed to develop a functional demonstration as each step of this evolutionary process unfolds.

Positive Findings

- The operators in the USPACOM TCCC use the network monitoring tools.
  - TCCC Status Grid
  - Impact Statement editor/display
  - Automated Brief (on hold)
- When AIDE data become available, then the AIDE visualization tools will be live.
- Two major architectural pieces have been built. The NetOps visualization engine (Figure 5), and the OneWay Proxy (Figure 6). The proxy uses a plug-in architecture. Plug-ins for AIDE and BMC Patrol have been implemented. These pieces can be quickly adapted to support other forms of data as an input source.
- The portal approach allowed several different presentations to be quickly implemented.
  - Flexibility of display and screen space usage
  - XML Application Program Interface (API) for external access to NetOps generated data

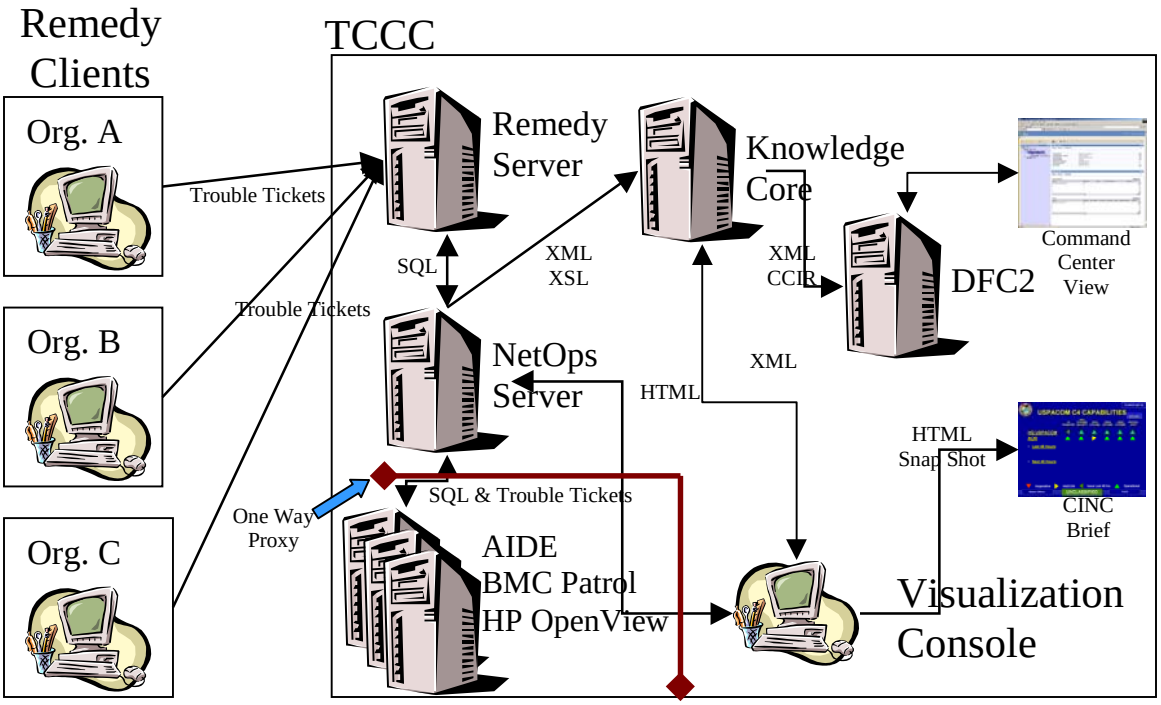

Figure 5. Visualization architecture.

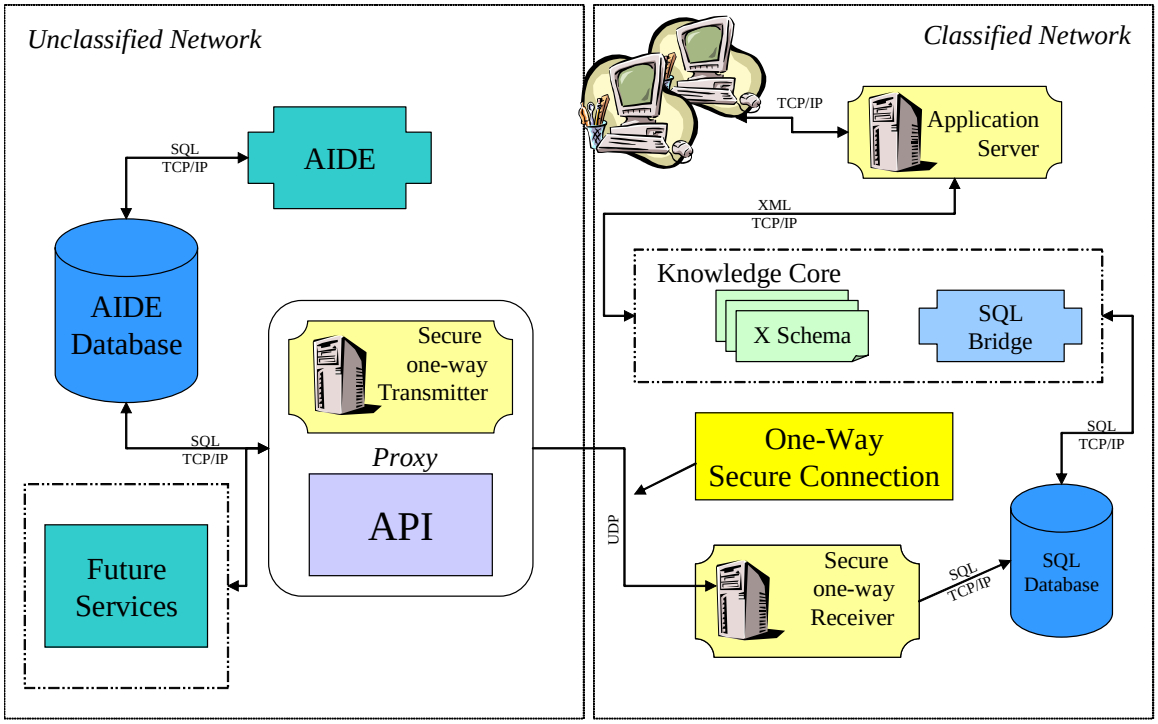

Figure 6. One-Way Proxy.

Remaining Challenges

- Continuous access to an AIDE data stream has not been achieved either locally in the AITS–JPO or at USPACOM. This renders the information assurance visualizations inactive.
  - Events Involving Critical Servers
  - EPC
  - Link Analysis
- The Continuously Computed Impact Point (CCIP) at USPACOM was flooded by a broken water pipe. The flood destroyed several computers, including the computer that supported NetOps. NetOps has since been deployed in the IEC at AITS–JPO but was not designed to adequately handle the large latency times encountered as packets move between AITS–JPO and USPACOM. The processing logic needs to be decoupled from the data mining logic.

Recommendations for Future

- Standardize the trouble ticket used by the entire Pacific theater. This change would allow all the organizations to quickly communicate network status to the TCCC.
- Spend more time with the operators in the TCCC to gain a better understanding of their business processes.
- Fully define the appropriate integration points between DFC2 and NetOps.
- Provide a business logic module that would allow an operator to define simple business logic status rules.
- Provide a module that would allow the operator to author automated briefs

Net Ops Status Monitoring Summary

The EICS is an advanced visualization that provides the ability to track statistics about attacks on critical servers. EICS is a valuable tool for network operations and is rated GREEN for Suitability. It is rated YELLOW for Usability and Technical because the visualization display needs to be reformatted to facilitate better comprehension by the users, and it is currently inactive at USPACOM.

The EPC is a stacked bar chart visualization showing Information Assurance (IA) status of AIDE system over the last 30 days. EPC is rated GREEN for Suitability and Usability because it provides a quick snapshot visualization of IA activity, as well as drill-down capability to view details of the individual events. It is YELLOW for Technical because it is currently inactive at USPACOM.

The Link Analysis is an advanced visualization showing IA status of attackers/attackees. The ability to draw information from IA sensors and track developments is very important. Thus, Suitability for Link Analysis is rated GREEN. It is rated YELLOW for Usability and Technical because the visualization tends to become crowded with data and requires additional filtering capability.

The composite ratings for Net Ops Status Monitoring are shown below. The various capabilities are viewed as valuable assets for the TCCC and for keeping track of the Theater network status. Thus, Suitability is rated GREEN. Given the problems associated with implementation and integration of the tools, Usability and Technical are rated YELLOW.

Net Ops Status Monitoring	Suitability	Usability	Technical
			

BMC Patrol

Providing enterprise network management capabilities that can monitor the status of key servers and the health of the network, as well as the ability to interface with other network management tools such as Tivoli®, Hewlett-Packard OpenView®, and Remedy®, is an important network infrastructure activity. PATROL® was identified as a Gold Nugget by the JWID 2000.

Current network operations utilize highly skilled technicians actively monitoring computer and communication systems for failures. Usually, hardware, software, or network failures are discovered by the customers, reported to a help desk facility, which records the problem report and forwards it either manually or automatically for resolution. PATROL® is an automated discovery process that understands not only when major failures occur, but also interprets the accumulation of minor events that lead to customer-service-level degradations. These same processes can automatically recover from minor failures without demanding the time and skills of system administrators. This ability will form a service-level management model that is focused on the customer's requirements. PATROL® hardware, software, and processes define customer centered service level management.

PATROL® performs the following functions:

- Collects and analyzes real-time events and data.
- Diagnoses and resolves problems before end-users are affected.
- Optimizes system performance and prevents outages.
- Reports deviations from expected service levels.
- Predicts how changes in the environment will affect future service levels.

Fielding

The CINC 21 ACTD assisted in installation and fielding of PATROL® at the AITS–JPO and at USPACOM. The following components were installed, demonstrated, and configured:

Enterprise Management

- PATROL® Enterprise Manager (PATROL® EM)
- PATROL® Enterprise Manager Agent Connection

- PATROL® Integration for Hewlett-Packard OpenView® Network Node Manager (AITS–JPO only)
- PATROL® Integration for Tivolli® (AITS-JPO only)
- PATROL® Integration for Remedy® Action Request System (ARS) (AITS–JPO only)
- PATROL® Operations Manager (AITS–JPO only)
- PATROL® Service Reporting (AITS–JPO only)
- PATROL® Explorer (Console)

Application Service Management

Operating System Layer

- PATROL® for Microsoft Windows® 2000 Server
- PATROL® for Unix

Applications/Services Layer

- PATROL® for Microsoft® Exchange Server (AITS–JPO only)
- PATROL® for Microsoft® Structured Query Language (SQL) Server (AITS–JPO only)
- PATROL® for Internet Services
- PATROL® for Oracle® (AITS-JPO only)
- CINC 21 Developed Knowledge Module for CuSeeMe® (AITS–JPO only)

Console

- PATROL® Console

  Positive Findings

  - PATROL® installation at the AITS-JPO showcased total enterprise monitoring capability between Hewlett-Parckard OpenView® (HPOV), Remedy®, and Tivolli®.
  - During JWID 2002 PATROL® integration with HPOV and Remedy® was used to generate network status matrices automatically.
  - One-way feeds from low-to-high implemented at AITS–JPO to obtain PATROL® monitoring and intrusion detection system events to a top-level enterprise manager on the high side.
  - PATROL® Explorer maps generated for AITS–JPO and USPACOM TCCC.
  - PATROL® knowledge module developed to monitor DCTS (CuSeeMe) at AITS–JPO.
  - PATROL® integration with various network managers and trouble ticket systems provides an excellent capability for enterprise management without requiring installing it on the entire enterprise.

Remaining Challenges

- PATROL® visualizations are not easily generated (side of the PATROL® console).
- PATROL® Enterprise Manager maps are not compatible with PATROL® Explorer maps (vector vs. raster).
- PATROL® Explorer raster maps do not have sufficient resolution as opposed to PATROL® Enterprise Manager vector maps.
- PATROL® service reporting ideally requires separate hardware to collect reportable statistics over a 30-day period.
- Training is definitely required to install, operate, and configure the product(s).
- Cooperation (e.g., security permission) with the various stakeholders is a must especially where no single organization controls the network, servers, and applications.
- PATROL® reports a number of valuable network and application events out of the box, however it must be tweaked for threshold settings and generally takes about 1 to 6 months (depending on the installation) to configure it properly for the enterprise.
- Until an interface between the PATROL® Enterprise Manager and NMCI is developed, the TCCC will not be able to monitor the complete enterprise.

BMC Patrol Summary

BMC patrol provides a comprehensive set of network management tools. These tools give network managers the ability to interact with other management tools, thus providing the user with a needed capability and supporting a GREEN Suitability rating. Difficulties generating visualizations and displaying vector and raster maps lead to a YELLOW rating for Usability. The technical rating is also YELLOW due to the installation and configuration demands and instabilities.

BMC Patrol	Suitability	Usability	Technical
	G	Y	Y

Special Projects

The special projects were single attempts to develop a tool or application for a specific use. Most of these projects were hardware or software that did not lend themselves to any meaningful assessment other than proper installation and operation. Some of these special projects, however, were assessed and include the following:

- USSTRATCOM Portal
- JWID Administrative Portal
- Quality of Service (QoS)

- Time-Step Virtual Private Network (VPN)
- Remote Routing Access Server (RRAS) VPNs with Public Key Infrastructure (PKI)
- 3Com® Embedded Firewall (EFW) NIC Cards
- Internet Protocol version 6 (IPpv6)
- NetIQ
- Net VCR
- Multi-Router Traffic Graphing (MRTG) tool

USSTRATCOM Portal

Assessment Events

- USSTRATCOM Consequence Management/Response Demonstration (Oct 02) (Appendix I)

Senior decision-makers were guided through an exercise, and then feedback was collected on how the CINC 21 technologies (including the C2 Portal) were perceived to support work processes in Consequence Management/Response. In addition, human factors professionals performed heuristic evaluations of the user interface.

Suitability

Positive Findings

A1. The accuracy of situation awareness and understanding among decision-makers was increased.

B1. The time needed to collect, identify, and integrate information was reduced.

B3. The time to display requested information decreased, so that additional time is available for analyzing decision options.

H1. The currency of information was sufficient for the decision-maker's requirements.

H2. The completeness of the information was sufficient for decision-makers' requirements.

H6. The amount of relevant data available within the decision cycle increased.

G2. Decision choices for crisis response were framed faster.

I8. CINC 21 technologies were accepted by the target users.

Remaining Challenges

H3. The precision of information was not sufficient for decision-makers requirements.

Usability

Positive Findings

A2. Ability to scale and tailor visualization displays increased.

D2. The number of steps or procedures used to exchange information was reduced.

E1. The number of actions needed to coordinate between participants was reduced.

I3. Workload was reduced.

I5. The number of staff needed to perform the task was reduced.

I7. Watchstanders were able to relay information faster when managing routine theater activity.

J2. Conveyance of information on the display device platforms was supported.

J3. The information was presented in a form that was usable by all distributed members.

L1. The time was reduced in establishing a collaborative framework.

Remaining Challenges

--NONE--

Technical

Positive Findings

A3. The decision support and knowledge management was advanced.

J1. Information transmittal attempts were successful.

Remaining Challenges

H2. The completeness of the information was not sufficient

K5. The system did not provide a secure means for exchanging information among distributed users.

General Findings

Positive Findings

- The portal provides current information to all users.
- It decreases the number of steps and staff needed to develop and exchange information.
- Target users accepted the portal.

Remaining Challenges

- The portal is unable to exchange information across security levels.
- The number of steps required to drill down for more detail needs to be reduced.
- An improved human–computer interface is needed to enhance usability.
- There are unresolved procedural issues regarding dynamic updating.

- The completeness of information was not sufficient for decision-makers' requirements (still in development).

USSTRATCOM Portal Summary

During the USSTRATCOM October 2002 demonstration, senior decision-makers said that the C2 Portal was a valued addition to their current process. Suitability thus receives a GREEN rating.

Usability receives a GREEN rating, although some human–computer interface improvements are needed. Also, care must be taken in limiting the number of levels a user will have to access to find information while in the middle of giving a briefing.

As for the Technical category, a YELLOW rating is assigned. At the time of the assessment, the portal was not fully functional. The portal was unable to exchange information across security levels. The composite ratings for the USSTRATCOM Portal are shown below.

USSTRATCOM Portal	Suitability	Usability	Technical
	G	G	Y

JWID Administrative Portal

Assessment Events

- Joint Warrior Interoperability Demonstration (May 02) (Appendix U)
- HCI evaluation (May 02) (Appendix Y)

  Data were collected from distributed operational users in four coalition countries (Australia, Canada, the United Kingdom and the United States) as they used the JWID Administrative Portal to perform scenario tasks during the Joint Warrior Interoperability Demonstration in May 2002. Users also completed questionnaire items that addressed various issues concerning functional utility and interface usability. In addition, human factors professionals performed a heuristic evaluation of the user interface in a laboratory environment.

Suitability

Positive Findings

A1. The accuracy of situation awareness and understanding among decision-makers was increased.

B1. The time needed to collect, identify, and integrate information was reduced.

B3. The time to display requested information was decreased, so that additional time was available for analyzing decision options.

C1. Planners' satisfaction with the decision was increased.

E3. Synchronization of information management among key players was increased.

F2. The sharing of inputs among the decision-makers was increased.

F3. The ability to generate alternative COAs was improved.

I8. Target users accepted CINC 21 technologies.

Remaining Challenges

G2. Decision choices for crisis response were not framed faster.

Usability

Positive Findings

J3. Information was presented in a form that was usable by all distributed members.

Remaining Challenges

D2. The number of steps or procedures used to exchange information was not reduced.

I6. CINC 21 technologies did not facilitate mission-relevant training.

J2. Conveyance of information on the display device platforms was not well-supported.

L1. Time was not reduced in establishing a collaborative framework *(display of data for collaborative efforts).*

Technical

Positive Findings

A3. Decision support and knowledge management was advanced.

K2. The controllers had central access to coalition non-combatant evacuation operation information.

Remaining Challenges

J1. Information transmittal attempts often were not successful.

K3. Increased control of C2 infrastructure did not provide security assurances across multiple networks, databases, and applications.

M1. Server compatibility was a problem.

General Findings

Positive Findings

- Coalition partners were able to share information quickly.
- Coalition partners were able to gain situation awareness and understanding quickly.
- Coalition partners were able to synchronize their planning efforts.

Remaining Challenges

- The capability to establish and maintain stable connectivity is needed.
- User assistance in the forms of embedded training, user aids, and on-line help is currently not available.
- The number of steps required to manipulate information within the framework of multiple applications is excessive.
- The user interface needs to be designed for real operational use, not to support specific exercises.

JWID Administrative Portal Summary

Users endorsed the value of collaborative planning and sharing operational planning information. However, the JWID Administrative Portal was not designed as a transition-quality product. It was a vehicle to integrate (1) diverse applications developed by the coalition partners and (2) the JWID scenario. The lack of ability to generalize [SRB2]to other settings is the principal reason for the YELLOW rating for Suitability.

Multiple modes were available on the JWID Administrative Portal for users to access the diverse coalition applications. However, the location of these applications was not clearly outlined. Some web parts were located off the screen with no indication of their existence unless the user scrolled down the page. There was no online user assistance and little training. Many users found that navigating within the portal and manipulating information on the portal was difficult. Usability is rated YELLOW.

Establishing and maintaining connectivity was a problem of such magnitude that users could not separate the system support issues from the applications themselves. There were repeated disruptions to the collaborative sessions and the sharing of information. The Technical rating is RED.

JWID Administrative Portal	Suitability	Usability	Technical
	Y	Y	R

Quality of Service (QoS)

Quality of Service (QoS) is a set of capabilities that allow you to create differentiated services for network traffic, thereby providing better service for selected network traffic. With QoS, you can increase bandwidth for critical traffic, limit bandwidth for non-critical traffic, and provide consistent network response. Implementing QoS in your network can allow the efficient use of expensive network connections. Service Level Agreements (SLAs) can be established directly with the customers of the network.

The CINC 21 ACTD collaboration activities require the ability to provide acceptable quality audio (and sometimes video) over DoD unclassified, secret, and coalition data networks. QoS mechanisms based on the Internet Engineering Task Force (IETF) Differentiated Services mechanisms have been used by CINC 21 to prioritize important collaboration traffic during demonstrations and exercises. Packets are marked for prioritization (e.g., critical, flash, etc.)

at the edges of the network, and the core routing devices must be configured to honor the markings. The experience and knowledge gained from these network prioritization activities has been passed on to other DISA activities and plans are in the works to field them on the operational DoD networks.

Fieldings

CINC 21 QOS capabilities have been fielded in various configurations, and on the DISN-LES Unclassified and Coalition networks. They are as follows:

- October 2000 five node demonstration of CINC 21 support of collaboration traffic with QoS for the USPACOM Deputy COCOM (Figure 7). Two sites in Hawaii, two sites in Virginia, and one in San Diego were linked by TimeStep VPNs over the Unclassified but sensitive (N-level) Internet Protocol Router Network (NIPRNET) and DISN–LES Unclassified networks. The Cisco® QoS Policy Manager was used to configure Cisco® routers in the network to prioritize the collaboration traffic over other traffic on congested links. With the QoS mechanisms turned on, the audio and video were of good quality; without them turned on, the video and audio quality was very poor.
- JWID'01 and JWID'02 exercises on the DISN-LES Combined Federation Battle Labs (CFBL) network, QoS was set in the Cisco® routers of the Combined Federated Battlelab Net (CFBLNet) to prioritize the IP Phone traffic used to coordinate between sites in the U.S. and participants in the U.K., Canada, Australia, and New Zealand. In JWID '02, additional work was done to prioritize the DCTS traffic.

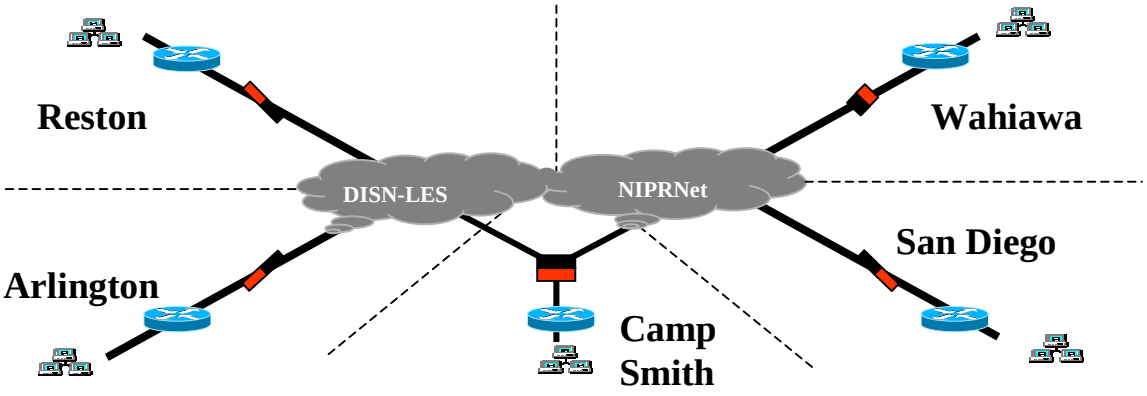

Figure 7. CINC 21 QoS and VPN configuration for October 2000 demonstration.

- Multi-Protocol Label Switching (MPLS) QoS. CINC 21 staff worked with North Atlantic Treaty Organization (NATO) engineers to set up a MPLS VPN with QoS over the Unclassified DISN-LES.

  Positive Findings

  - QoS capabilities were demonstrated in various demonstrations and exercises.
  - QoS-enabled networks with changing policies can benefit from use of Cisco® QoS Policy Manager to set policies on many routers quickly.

Remaining Challenges

- There needs to be business rules/operational procedures to decide who gets priority on operational networks.
- Rules are needed to determine what gets prioritized. Prioritization of audio and text collaboration is the first choice; video should only be prioritized if it is critical.
- Password access to the routers in the network is needed.
- More "QoS-aware" applications are needed.

Recommendations for Future

- Test results showed that QoS could be used to satisfy Service-Level Agreements with network customers.
- The use of QoS mechanisms is critical to supporting multimedia over IP networks. CINC 21 staff have provided inputs to two DISA working groups; one doing IP QoS evaluations and experiments, and the other doing MPLS QoS work. It is expected that some of these capabilities will be fielded on the operational NIPRNet and Secret IP Router Network (SIPRNet) soon.

QoS Summary

CINC 21 successfully fielded various Differentiated Services based on QoS configurations on multiple networks. A Cisco® QoS Policy Manager was delivered to CINCPAC for their further use and evaluation. The capability does provide flexibility in network traffic management. Thus, Suitability is GREEN. Not enough data were collected, however, to assess the Usability or Technical classifications.

Quality of Service	Suitability	Usability	Technical
	G		

Virtual Private Network (VPN)

CINC 21 provides protected network connectivity between users at multiple sites, and in some cases, connects individuals working from home or a hotel to a CINC 21 server site. VPNs have been used to provide this environment, using Internet Protocol Security (IPSec) encapsulation and encryption to protect against external tampering and eavesdropping. IPSec is an evolving standard from the IETF, supporting authentication, privacy, and key management. A long-term DoD goal is to use IPSec VPNs to create Secret and above enclaves over unclassified networks. IPSec is not NSA-Type I-approved at this time, so it can be used to provide privacy, but cannot replace Tactical FASTLANE® (TACLANE)/National Encryption System (NES)-type packet encryptors for U.S. Secret and above data.

One popular use of IPSec-encrypted VPNs today is to encapsulate collaboration traffic such as Microsoft NetMeeting®, which is blocked by most firewalls because it requires numerous ports to be opened. The encrypted VPN uses only one port and has the added benefit of providing privacy to the collaboration session.

When the CINC 21 VPN activity was started, there was only one FIPS 140-2 certified VPN Gateway—the Alcatel® TimeStep VPN Gateway. Later, the Cisco® 3000 series VPN Concentrator was added to the FIPS 140-2 certified list. NSA strongly recommended that CINC 21 only use certified devices. In addition to TimeStep, CINC 21 looked at the Microsoft® Remote Routing and Access Server gateway VPN.

Fieldings

CINC 21 VPNs have been fielded in various configurations and on unclassified and classified networks (see Appendix Z for details regarding the RRAS VPN). Fielded VPNs are as follows:

- October 2000 five-node demonstration of CINC 21 VPNs supporting collaboration traffic with QoS and tunneled IP Multicast for the USPACOM Deputy COCOM (Figure 7). Two sites in Hawaii, two sites in Virginia, and one in San Diego were linked by TimeStep VPNs over the NIPRNET and DISN–LES unclassified networks.
- VPN between USSTRATCOM and the AITS–JPO on the Secret DISN–LES and SIPRNET using TimeStep VPN Gateways. This configuration provided DCTS collaboration capabilities for USSTRATCOM users interfacing with USPACOM and AITS–JPO users. The VPN gateway at the AITS–JPO was configured to support split tunneling, with traffic to/from USSTRATCOM IP addresses getting encrypted/ unencrypted, while all other traffic was configured to pass through the VPN Gateway in "clear" unencrypted mode. This configuration allowed users in USPACOM without VPN capability to connect to a collaboration server at the AITS–JPO that was linked with USSTRATCOM, supporting collaboration sessions with all sites. The diagram below (Figure 8) shows the basic configuration.

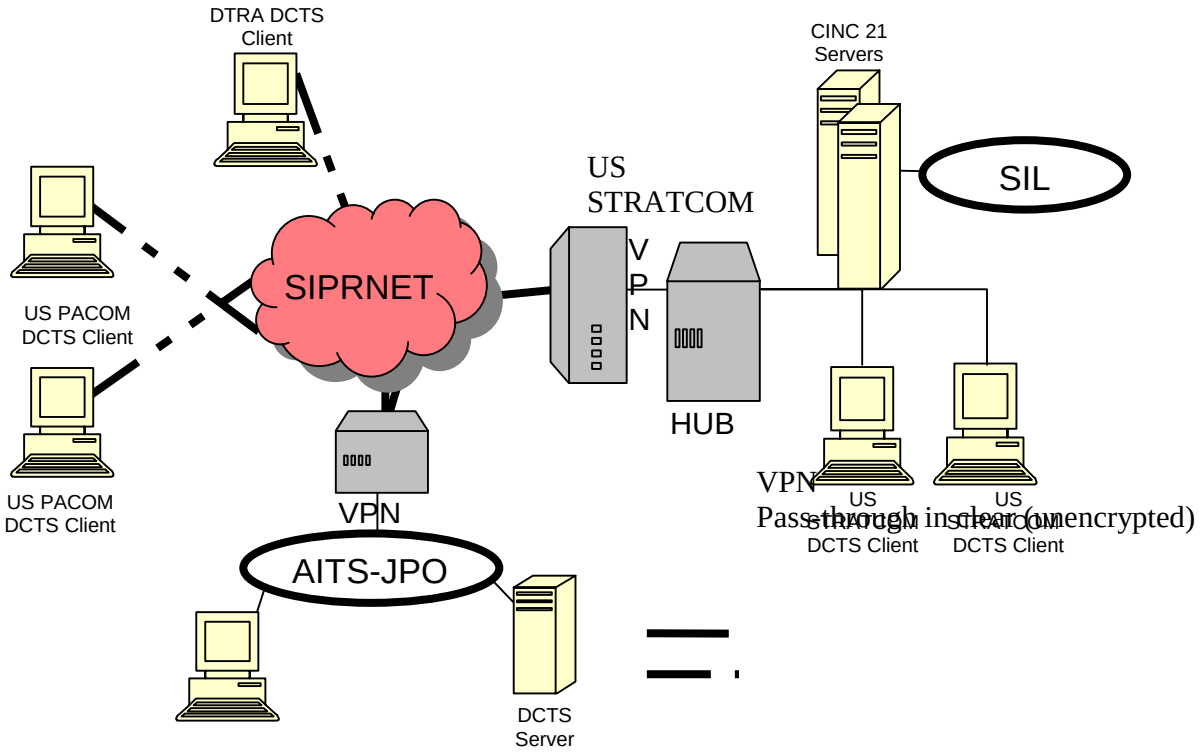

Figure 8. CINC 21 VPN configuration between USSTRATCOM and the AITS-JPO.

- VPNs supported the CINC 21unclassified development environment at MITRE. TimeStep VPN gateways were fielded at MITRE and the AITS–JPO on the unclassified DISN–LES to support CINC 21 development efforts. This configuration required the ability to allow remote users to connect from the Internet using client VPN software. The TimeStep VPN client was unsatisfactory for this purpose. It was difficult to load on users' personal computers and most difficult to remove—usually requiring a complete rebuild of the system.

  CINC 21 fielded the Microsoft® RRAS at MITRE to provide better VPN client support. The RRAS server worked with the VPN client that comes with Windows® 2000, strict lockdown procedures were performed on the RRAS server, and users were given PKI certificates for user authentication. Appendix Z is a report from the Joint Information Operations Center, Information Warfare Analysis Division on a security analysis of the Microsoft® RRAS/Alcatel® Permit Timestep 4600 VPN Gateway combination solution and the Cisco® VPN concentrator/Microsoft® Internet Authentication Service (IAS), Remote Access Dial-In Service (RADIUS), combination solution.

- Multi-Protocol Label Switching (MPLS) VPN. CINC 21 staff worked with NATO engineers to set up a MPLS VPN over the Unclassified DISN–LES. This type of VPN provides encapsulation (not encryption) and routing isolation. DISA is interested in this configuration for the future.

- Cisco® 3030 and 3005 VPN Concentrators. When Cisco® was added to the FIPS 140-2 certified list, CINC 21 staff evaluated the product for potential future use. The Cisco® 3000 series VPN Concentrators function well as VPN gateways, and the Cisco® client is easy to load and unload from user personal computers, unlike the TimeStep client.

  Positive Findings

  - VPNs tunneling through firewalls for collaboration. The unclassified networks have many firewalls that otherwise block the collaboration tools that use dynamic (changing) ports. VPNs encapsulate this traffic into one port. Hardware acceleration built into the TimeStep and Cisco® VPN gateways allow for acceptable performance of collaboration—otherwise the overhead of encryption can cause degraded audio and video.
  - Split VPN tunnel for USSTRATCOM—connecting users that could not otherwise collaborate over the SIPRNET.
  - Class/QoS using Differentiated Services capabilities for VPNs.
  - Internet Protocol (IP) Multicast tunnels through VPNs.
  - Use of PKI for user authentication.

  Remaining Challenges

  - TimeStep VPN client software is judged as not user/PC friendly.
  - PKI authentication is good to do, but key management is difficult and time consuming.

- Microsoft® RRAS is the most convenient VPN gateway for users, but it is too vulnerable to attack because it runs the Microsoft® Operating System. The TimeStep and Cisco® VPN Gateways are dedicated boxes and less vulnerable to hackers.
- Remote clients connecting through the RRAS server sometimes experienced excessive delays/timeouts that were due to Domain Name Service (DNS) and WINS problems.
- Scaling issue: Management of multiple VPNs difficult—each VPN is a different network and you need connectivity and management/monitoring tools on each.

Recommendations for Future

- In the future, significant cost savings could be obtained through the use of NSA Type-1–certified, IPSec-based VPNs. This configuration could become a reality within the next year.
- Use Cisco® VPNs for the near term—they are FIPS-140-2-certified and have user-friendly client software.

VPN Summary

CINC 21 successfully fielded various VPN configurations on multiple networks. The VPN tools do offer some capability, but they do not appear well matched for the warfighter needs. Suitability, then, is rated YELLOW. Not enough data were collected, however, to assess the Usability or Technical classifications. It should be noted that VPNs are considered to be the best route for providing the necessary security within networks. Future efforts in VPN are expected to provide this capability in a reliable and usable form to all warfighters.

VPN	Suitability	Usability	Technical
			

3Com® Embedded Firewall (EFW) NIC Cards

Protecting against insider threats is an issue of concern to the CINC 21 ACTD. VPN gateways and firewalls are placed at the entrance to sites to protect against outsider threats, but little is normally done to protect against insider threats. The 3COM® Embedded Firewall product was evaluated by CINC 21 and used in JWID'02 to detect and block a Denial of Service attack. The EFW capability is built into commercially available Ethernet NIC cards and managed from a management station running the 3COM® EFW Policy Manager. A vulnerability assessment of the 3COM® EFW was funded by CINC 21 and performed by the Joint Information Operations Center Branch (JIOC) Technology Evaluation.

The 3Com® EFW is a product and technology that prevents insider attacks and outside hacks by placing a low-cost, easy-to-use network access control point directly in front of each critical host on the network. The EFW network access control point is independent of the host and controls all accesses to and from the host. This independence means it protects the

network from attacks launched from the host itself, as well as protecting the host from network attacks. It also means a user or malicious code that gains access to administrator mode on the host cannot modify the configuration of the access control point. All the EFW access control points in an enterprise are centrally managed, and each has a simple, easy-to-understand security policy. These are as follows:

- 56- to 70-MB data throughput increase with encryption offloading to the card
- EFW is stronger than host/application security because it is independent of the existing host OS
- Survivable security solution (NIC is very secure in itself)
- Provides fiber support
- Provides thin-client support
- Intrusion detection capabilities (can detect when unauthorized user is using policy server and shut application down)

The EFW has the three properties that are the focus point for security:

- It is tamper-proof in that the policy and enforcement mechanism can only be changed by authorized administrators.
- It cannot be bypassed, so the only way to go between the network and the host is through an EFW access control point.
- The policies are simple enough to be analyzed by a security auditor who wants to ensure the system is enforcing an appropriate security policy.

The EFW system architecture consists of a centralized Policy Server that distributes access control policies to its slaves. The slaves are 3Com® 3CR990 NICs on the hosts protected by the EFW. The 3CR990 was designed in collaboration with Microsoft® for optimal IPSec VPN performance on Windows® 2000 and Windows® XP hosts. It has an onboard encryption chip for IPSec encryption as well as a RISC processor.

Secure Computing has developed new security firmware that runs on the Reduced Instruction Set Computer (RISC) processor and converts the NIC into an EFW component. This firmware converts the NIC into a security slave of the central Policy Server, also developed by Secure Computing. That is, the NIC only accepts policy configuration information that comes over an encrypted communication channel from the Policy Server.

Managed by the Policy Server, each NIC enforces a firewall policy that filters access to the host based on source and destination IP addresses and ports. It also filters based on whether or not its protected host initiates the session. Thus, it controls what services the protected host provides to each remote host.

Fieldings

The EFW NICs were fielded at the AITS–JPO on the Unclassified DISN–LES for testing along with an installation at USPACOM during JWID. During JWID, the cards were used to demonstrate how denial of service could be managed and blocked once it was detected.

Positive Findings

- Basic functionality. The 3Com® EFW NIC was tested and verified (i.e., ability to shutdown specific ports and services such as ftp and telnet).
- The Policy Server distributed policies to Client NIC cards without delay or utilizing much of the system resources.
- Firewall functionality is independent of the host Operating system.
- Successful block of malicious traffic during JWID.

Remaining Challenges

- NIC cards are easily rendered inoperable.
- Virtual Private Group capability—the ability to have VPNs among groups not just peer to peer. This capability was promised, but not available on the version used for testing.
- Failed attempts in connecting clients at multiple sites.
- Tested version of the Policy Server did not support Ipsec with Windows® 2000 VPN capability. This function would be available in a later version.

EFW Summary

There was little opportunity to assess this capability, i.e., not enough data were collected to assess any of the mission effectiveness criteria.

EFW	Suitability	Usability	Technical
			

Other Special Projects

Several other Special Projects were also initiated. Technical assessments were made on the following capabilities:

- Internet Protocol version 6 (IPpv6)
- NetIQ
- Net VCR
- MRTG tool

Internet Protocol version 6 (IPv6)

IPv6 is an emerging standard that will have a big impact on the DoD in 5 to 10 years. CINC 21 collaborated with SSC Charleston to build a native IPv6 testbed that communicates over the Unclassified DISN–LES (Leading Edge Services) network. The JIOC performed a security evaluation of IPv6. The testing showed that not all the necessary capabilities are complete and hardening of the technology is needed. IPv6 is rated YELLOW for Technical because there is still significant work to be done with the

protocol before it can be fielded widely. There is not enough information to rate Suitability and Usability.

IPv6	Suitability	Usability	Technical
			

NetIQ

NetIQ is a network performance monitoring tool used by CIN C21 during JWID '02. It is very good at measuring application and server performance and network bandwidth availability and is included in the recommended set of recommended tools in CINC 21. It is rated GREEN for Technical because it is a commercial off-the shelf product that provides critical network information. There is not enough information to rate Suitability and Usability.

NetIQ	Suitability	Usability	Technical
			

NetVCR

NetVCR was used in JWID '02 to provide detailed performance measurements and playback capability of traffic to critical CINC 21 servers. It is included in the set of recommended CINC 21 tools because it provides detailed information on critical parts of the network infrastructure. It is rated GREEN for Technical, but it is a costly item and is normally needed at multiple locations. There is not enough information to rate Suitability and Usability.

NetVCR	Suitability	Usability	Technical
			

Multi-Router Traffic Graphing (MRTG) Tool

The MRTG tool was used in JWID '00, JWID '01, and JWID '02 by CINC 21. It is a freeware tool that collects and graphs aggregate traffic on router and switch ports. It is included in the set of recommended CINC 21 tools. It is rated YELLOW for Technical because many of the DoD networks block the SNMP (Simple Network Management Protocol) traffic that MRTG requires to provide status. There is not enough information to rate Suitability and Usability.

MRTG	Suitability	Usability	Technical
			

CINC 21 Prioritized Requirements

The CINC 21 Operational Manager identified 44 system requirements for advanced information technology. These requirements help to specify the four COIs in greater detail. USPACOM staff then prioritized these requirements. CINC 21 technology focused on the top 27 priority requirements. The summary of assessment ratings of the complete set of prioritized requirements is shown in Table 11 along with the applicable COI and CINC 21 technology.

Table 11. Summary of prioritized requirements.

Priority	System Requirement	COI	Technology	Assessment
1 [details]	Develop the standard desktop client workstation configuration and software to allow command / staff organic support (CINC 21-configured desktop workstation).	1 – Decision Focused Visualization	EWS (not assessed directly)	
2 [details]	Provide domain-independent mechanisms for dynamically tailoring the presentation of information to a decision-maker based upon their activities.	1 – Decision Focused Visualization	DFC2 COA Matrix FBV AOR Basing TCCC Conseq. Mgt.	
3 [details]	Provide domain-independent mechanisms for displaying linkages between related events / items both within and across windows, including drill-down.	1 – Decision Focused Visualization	DFC2 COA Matrix FBV AOR Basing Message Tracker	
4 [details]	Provide generalized XML-capable browser and integrate with the KM database.	1 – Decision Focused Visualization	DFC2 STRATCOM Portal	
5 [details]	Provide open, extensible geo-situation software that allows acceptance of data and geo-rendering with complete filtering, labeling, and overlay control.	1 – Decision Focused Visualization	XIS provided as part of AOR Basing (not assessed directly)	
6 [details]	Provide the standard distributed collaboration software client configuration and software to allow command / staff organic support to users.	3 - Collaboration	DCTS	
7 [details]	Develop a thematic collaboration system that processes information, produces summaries and links it to other information articles, allows analysis and collaboration.	3 - Collaboration	DFC2	
8 [details]	Develop a solution for secure authentication on SIPRNET among the COCOM's staff, JTFs, and Components.	Not addressed sufficiently to allow assessment. 4 - Security	User Management	
9 [details]	Provide tools for monitoring and visualizing information flows across the theater based upon content, priority, and purpose.	4 – Enterprise Awareness	DFC2 COA Matrix FBV AOR Basing	

Table 11, continued.

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Priority	System Requirement	COI	Technology	Assessment
10 [details]	Provide tools for constructing and viewing the Information Assurance COP.	not addressed		
11 [details]	Provide unclassified restricted (e.g., NIPRNET) conference server to support multiple distributed collaboration sessions internal to DoD.	3 - Collaboration	DCTS	
12 [details]	Develop a secure mechanism that enables collaboration tools to work in the presence of firewalls.	4 - Security	DCTS IWS VPN	
13 [details]	Provide a secret conference server to support multiple distributed collaboration sessions with US units.	3 - Collaboration	DCTS IWS	
14 [details]	Provide unclassified, unrestricted conference server to support multiple distributed collaboration sessions with organizations and agencies external to US DoD.	3 - Collaboration	DCTS	
15 [details]	Field collaboration tools to the COCOM, JTF, and Component Commanders that provide VTC, voice, instant messaging, shared virtual workspace, shared whiteboard, and shared applications.	3 - Collaboration	DCTS IWS	
16 [details]	Implement a solution to achieve run-time interoperability among different collaboration tools.	Not addressed sufficiently to allow assessment. 3 - Collaboration	Collaboration tools	
17 [details]	Provide mechanisms for automatically setting up and managing collaboration sessions based upon workflow and operational priorities.	3 - Collaboration	DFC2	
18 [details]	Develop a solution for securely connecting the COCOM to his Allied counterparts over unclassified networks.	4 - Security	VPN	
19 [details]	Provide secret conference server to support multiple distributed collaboration sessions with allies.	3 - Collaboration	DCTS	
20 [details]	Provide mechanisms for automating staging and distribution of knowledge objects throughout the theater (integrate with IDM).	2 – Knowledge Management	Enterprise C2 Infrastructure, DFC2, COA Matrix and COINS	

Table 11, continued.

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Priority	System Requirement	COI	Technology	Assessment
21 [details]	Provide the semantic constructs required for knowledge exchange for critical COCOM/JTF warfighting and theater engagement processes.	2 – Knowledge Management	DFC2	
22 [details]	Provide tools that enable structured KM publishing processes that enable producers to publish their products as XML-based documents.	2 – Knowledge Management	Enterprise C2 Infrastructure	
23 [details]	Build a knowledge portal for viewing and navigating through the COCOM's Ops-Intel Brief, SITREPs, and Electronic Battlebook.	1 – Decision Focused Visualization	DFC2 JWID Admin Portal	
24 [details]	Provide knowledge portals for the JTF and Allies that enable easy access to COCOM-provided support services.	1 – Decision Focused Visualization	DFC2 JWID Portal	
25 [details]	Implement data extraction and automated assembly mechanisms for automating significant portions of the COCOM's morning brief.	2 – Knowledge Management	DFC2 COA Matrix RFI Conseq. Mgt. TCCC Msg. Tracker	
26 [details]	Develop automated brief preparation capability based upon content and update of the information / knowledge base.	1 – Decision Focused Visualization	DFC2 Consequence Mgmt.	
27 [details]	Develop consequence management and targeted briefing process.	1 – Decision Focused Visualization	DFC2 Consequence Mgmt.	
28 [details]	Develop the standard conference room configuration to allow command / staff organic support (CINC 21-configured conference room).	3 - Collaboration	DCTS IWS	
29 [details]	Develop DTDs for OPLANs and CONPLANs.	1 – Decision Focused Visualization	Enterprise C2 Infrastructure; Knowledge Core and DFC2: Decision Space Data Schema, Schema Management	
30 [details]	Develop the dynamic TPFDD.	Not addressed		
31 [details]	Implement mechanisms for automating processes consistent with the workflow management system currently under development at PACOM.	1 – Decision Focused Visualization	Task Management System (TMS)	

Table 11, continued.

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Priority	System Requirement	COI	Technology	Assessment
32 [details]	Provide next generation situation awareness, planning, and force execution tools to the COCOM and integrate with KM environment.	4 – Enterprise Awareness	DFC2 COA Matrix FBV AOR Basing	
33 [details]	Provide the infrastructure that enables selected portions of the COCOM's networks to support prioritized delivery of products and bit-streams.	Not addressed		
34 [details]	Field advanced protocols to significantly reduce traffic latency of selected information flows through theater networks.	Not addressed		
35 [details]	Develop an accreditable solution for auto-generation of security tags for archived data products based upon current coalition releasability policy.	Not addressed		
36 [details]	Provide high-resolution, large-screen displays to the COCOM that are capable of supporting simultaneous crises and day-to-day operations.	1 – Decision Focused Visualization	PACOM Video Wall STRATCOM K-Wall	
37 [details]	Develop mechanisms for dynamically managing the pixel real estate of large displays to improve comprehension.	1 – Decision Focused Visualization	PACOM Video Wall STRATCOM K-Wall	
38 [details]	Provide alerting mechanisms that auto-initiate appropriate visualization events.	Not addressed sufficiently to allow assessment. 4 – Enterprise Awareness	DFC2 FBV TCCC	
39 [details]	Implement homogeneous server-server federations.	4 – Enterprise Awareness	Enterprise C2 Infrastructure; Knowledge Core (XML Data Services) and DFC2 Schema management	
40 [details]	Develop the standard mobile client workstation configuration and software to allow command / staff organic support (CINC 21-configured mobile workstation).	Not addressed		
41 [details]	Provide high-resolution, large displays to a JTF capable of supporting simultaneous crisis operations.	4 – Enterprise Awareness	STRATCOM K-Wall PV290	

Table 11, continued.

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Priority	System Requirement	COI	Technology	Assessment
42 [details]	Provide a method for accessing knowledge objects across security enclaves with minimal latency.	Not addressed		
43 [details]	Prepare for the transition from Ipv4 to Ipv6 by performing selected experimentation and risk reduction activities on selected theater networks.	Not addressed		
44 [details]	Provide multi-modal human-computer interface capabilities (e.g. voice, head-tracking, gesture, hand-pointing).	Not addressed		

The following section provides a somewhat expanded discussion of the basis for the assessment of each CINC 21 requirement.

Priority Requirement 1 - Develop the standard desktop client workstation configuration and software to allow command/staff organic support (CINC 21-configured desktop workstation). [COI-1]

CINC 21 Technology – EWS (not assessed directly)

G Assessment – A standard CINC 21 desktop workstation configuration was developed and implemented at USPACOM. The EWS configuration included a standard hardware and software suite that has been certified for use in operational settings. The EWS has been used during several exercises and continues to be used daily for routine tasks. The configuration has been stable, and users learned to use the component tools quickly. System maintenance and upgrades have gone smoothly via onsite technical support staff and system administrators.

Priority Requirement 2 - Provide domain-independent mechanisms for dynamically tailoring the presentation of information to a decision-maker based upon their activities. [COI-1]

CINC 21 Technology – DFC2, COA Matrix, FBV, AOR Basing, TCCC, CM

Y Assessment – This capability has not been fully implemented in the current version of DFC2 or the other applicable tools. Several of them do, however, provide users with limited capability to manually tailor their information display to fit their needs. This tailoring is not yet automatically adjusted based on their activities.

Priority Requirement 3 - Provide domain-independent mechanisms for displaying linkages between related events/items, both within and across windows, including drill-down. [COI-1]

CINC 21 Technology – DFC2, COA Matrix, FBV, AOR Basing, and Message Tracker

Y Assessment – CINC 21 technologies provide limited ability to display linkages between related information. They also provide limited capability to drill down to get additional

detail as desired. Users reported that these capabilities would have substantial utility for them. Improvements in certain aspects of the user interface will enhance ease of use and training.

Priority Requirement 4 - Provide generalized XML-capable browser, and integrate it with the Knowledge Management database. [COI-1]

CINC 21 Technology – DFC2 Presentation Layer Portal, USSTRATCOM Portal

Assessment– Two portal environments were developed. The DFC2 was based on Digital Dashboard and incorporated fully integrated navigation, table, collaboration and timeline views with dynamic XML-enabled information access. It has been used in four USPACOM leveraged assessments and based on user input is undergoing upgrades to a more powerful Weblogic portal environment. The USSTRATCOM portal is based on a more conventional ORACLE® 9i portal environment. It uses dynamic XML enabled information access. It is operational at USSTRATCOM.

Priority Requirement 5 - Provide open, extensible geo-situation software that allows acceptance of data and geo-rendering with complete filtering, labeling, and overlay control. [COI-1]

CINC 21 Technology – XIS (not assessed directly)

Assessment–XIS provides web based geo-rendering tools. XIS provides XML based input and output capabilities as the client (Viewpoint) and Server. The XIS server tools form the basis of the Enterprise C2 Infrastructure geo-spatial XML data handling. The XIS server functionality is used for all exercises as part of the Enterprise C2 Infrastructure. The XIS Viewpoint has been IOC by J4 for AOR Basing Operational Package information access and display. It is not currently used due to lack of Data Base Access/Content.

Priority Requirement 6 - Provide the standard distributed collaboration software client configuration and software to allow command/staff organic support to users. [COI-3]

CINC 21 Technology – DCTS

Assessment – DCTS was provided to staff as the standard distributed collaboration software client configuration. Having a standard software toolset made it easier for users to collaborate and to exchange information. Substantial problems with DCTS were experienced over many different assessment events, however. Its military utility was limited by the degraded performance experienced when more than a few users were connected and the unstable connectivity. Collaboration often reverted to chat and other more reliable, low-bandwidth tools to overcome the technical problems of DCTS.

Priority Requirement 7 - Develop a thematic collaboration system that ingests information, produces summaries, and links it to other information articles to allow analysis and collaboration. [COI-3]

NC 21 Technology – DFC2 Assessment – Originally, a thematic collaboration system called Corporate Executive Information Systems (CEIS) was envisioned for CINC 21 to meet this priority requirement. CEIS was not developed, however, due to various technical challenges. Instead, the DFC2 concept was expanded to incorporate much of this

requirement. The DFC2 schema, visible to users via the Navigator, enables information to be organized by mission, phase, or other thematic category. Users can then access the original information, view summaries, and see links to other related information. In the current stage of DFC2 development, however, these functions are largely done manually and often require a great deal of time and effort by operators.

Priority Requirement 8 - Develop a solution for secure authentication on SIPRNET among the COCOM's staff, JTFs, and Components. [COI-4]

CINC 21 Technology – User Management

Assessment – This requirement was not sufficiently addressed to allow assessment. User Management capabilities not operationally functional.

Priority Requirement 9 - Provide tools for monitoring and visualizing information flows across the theater based upon content, priority, and purpose. [COI-4]

CINC 21 Technology – DFC2, COA Matrix, FBV, AOR Basing

Y Assessment – Tools have been created that afford the monitoring and visualizing of information flows. However, at the time of assessment they were still in various stages of development.

Priority Requirement 10 - Provide tools for constructing and viewing the Information Assurance COP.

CINC 21 Technology – none

Assessment – This requirement was not addressed by CINC 21.

Priority Requirement 11 - Provide unclassified restricted (e.g., NIPRNET) conference server to support multiple distributed collaboration sessions internal to DoD. [COI-3]

CINC 21 Technology – DCTS

Y Assessment – DCTS did enable multiple, distributed DoD groups to conduct unclassified collaborative sessions. As discussed in Requirement 6, the unstable connectivity and bandwidth problems degraded the utility of the collaborative sessions. Users needed to rely upon chat and similar techniques and were often unable to incorporate audio or video.

Priority Requirement 12 - Develop a secure mechanism that enables collaboration tools to work in the presence of firewalls. [COI-4]

CINC 21 Technology – DCTS, IWS, VPN

G Assessment – Video teleconferencing, text chat, and other collaboration tools were demonstrated at USPACOM in the presence of firewalls. VPN techniques enabled these exchanges to operate effectively. QoS techniques were demonstrated to significantly improve signal quality, making multi-modal collaboration more viable.

Priority Requirement 13 - Provide a secret conference server to support multiple distributed collaboration sessions with U.S. units. [COI-3]

CINC 21 Technology – DCTS, IWS

Assessment – DCTS was able to operate on the SIPRNET to support collaboration among multiple distributed staff within and across commands. As noted in Requirement 11, connectivity with DCTS was fragile and the quality of the video and audio transmissions degraded significantly as more participants joined the conference. Connectivity with IWS was much more stable.

Priority Requirement 14 - Provide an unclassified, unrestricted conference server to support multiple distributed collaboration sessions with organizations and agencies external to U.S. DoD. [COI-3]

CINC 21 Technology – DCTS

Assessment – Several of the DCTS tools were used to support collaboration among distributed, multi-national military teams during the JWID exercise. We expect that collaboration with non-military groups would be similar. While the capability to connect these groups did exist via a conference server, the quality of the exchanges was fair at best. The unstable connectivity that was experienced further reduced the military utility of this technology. Users tended to rely on chat and other more reliable tools.

Priority Requirement 15 - Field collaboration tools to the COCOM, JTF, and Component Commanders that provide video teleconference (VTC), voice, instant messaging, shared virtual workspace, shared whiteboard, and shared applications. [COI-3]

CINC 21 Technology – DCTS, IWS

Assessment– Two collaboration toolsets were provided along with two additional clients on the USPACOM electronic warfare system (EWS); DCTS, SAMETIME, an IWS client, and an Odyssey client. Full DCTS suites were installed at USPACOM and USSTRATCOM. USPACOM experienced significant performance issues with DCTS and did not make the suite operational, whereas USSTRATCOM is using DCTS operationally within the command. IWS clients were provided on the EWS at USPACOM. USPACOM is moving to make IWS operational. Odyssey was provided as a client on EWS but was not used by either command. SAMETIME clients and servers were installed at USPACOM only, and have been used only minimally.

Priority Requirement 16 - Implement a solution to achieve run-time interoperability among different collaboration tools. [COI-3]

CINC 21 Technology – Collaboration tools

Assessment – Not addressed sufficiently to allow assessment. Assessment events did not sufficiently address cross-application collaboration. The ability to transfer data between DCTS and IWS was demonstrated at USPACOM, however.

Priority Requirement 17 - Provide mechanisms for automatically setting up and managing collaboration sessions based upon workflow and operational priorities. [COI-3]

CINC 21 Technology – DFC2

Y Assessment – Automatic setup of collaborative chat sessions was achieved in DFC2, based on users' selection of operationally defined task objects. However, workflow priorities have not been incorporated.

Priority Requirement 18 - Develop a solution for securely connecting the COCOM to Allied counterparts over unclassified networks. [COI-4]

CINC 21 Technology – VPN

G Assessment – At JWID, use of an unclassified VPN allowed data retrieval by coalition partners located in four nations (Australia, Canada, United Kingdom, and United States) from shared databases.

Priority Requirement 19 - Provide a Secret conference server to support multiple distributed collaboration sessions with allies. [COI-3]

CINC 21 Technology – DCTS

Y Assessment – Several DCTS capabilities were used to support collaboration among distributed, multi-national groups during the JWID exercise. While the capability to connect these groups did exist via a classified conference server, the quality of the exchanges was fair at best. The unstable connectivity that was experienced further reduced the military utility of this technology. Again, users tended to rely on chat and other more reliable tools.

Priority Requirement 20 - Provide mechanisms for automating staging and distribution of knowledge objects throughout the theater (integrate with [IDM]). [COI-2]

CINC 21 Technology – Enterprise C2 Infrastructure, DFC2, COA Matrix and COINS

G Assessment – The Enterprise C2 Infrastructure is a collection of technologies that facilitate access to information throughout the theater. The hooks to IDM are available and ongoing discussions are underway with IDM as they propagate hardware and software into the COCOMs. DFC2 provides the access to the objects across the theater. The COA matrix and the COINS interoperability are based on the Enterprise C2 Infrastructure. The Enterprise C2 Infrastructure is operational on the SIPRNET. COINS is operational on COWAN and COA Matrix is operational at USSTRATCOM.

Priority Requirement 21 - Provide the semantic constructs required for knowledge exchange for critical COCOM/JTF warfighting and theater engagement processes. [COI-2]

CINC 21 Technology – DFC2

Y Assessment – DFC2 organized information around user-defined themes, such as missions, phases, etc. This explicit hierarchical structure provides semantic constructs that can facilitate knowledge exchange between COCOM and JTF, although there was no opportunity to assess whether these command levels found the DFC2 schema useful and meaningful.

Priority Requirement 22 - Provide tools that enable structured Knowledge Management publishing processes that enable producers to publish their products as XML-based documents. [COI-2]

CINC 21 Technology – Enterprise C2 Infrastructure

G Assessment – Three critical products in the infrastructure provide tools for XML indexing and publishing. Knowledge Board provides tools (Extensible Data Services – XDS) that provide document and web page XML service along with persistence. XIS server tools provide geo-spatial indexing and publishing tools for XML. ORACLE® 8i/9i servers provide the platform for actual persistence. All are operational on the SIPRNET and used in exercises.

Priority Requirement 23 - Build a knowledge portal for viewing and navigating through the COCOM's Ops-Intel Brief, SITREPs, and Electronic Battlebook. [COI-1]

CINC 21 Technology – JWID Admin Portal, DFC2

G Assessment – The JWID Admin Portal, which was not developed further after JWID, allowed users to view and navigate the COCOM's daily brief. This capability was highly rated by users. The DFC2 allows users to browse and link to documents such as SITREPS; however, the process is very cumbersome and time-consuming.

Priority Requirement 24 - Provide knowledge portals for the JTF and Allies that enable easy access to COCOM-provided support services. [COI-1]

CINC 21 Technology – DFC2, JWID Portal

Y Assessment – The DFC2 presentation layer portal is applicable across echelons. It can provide access to all support services, but was not used in this capacity. A form of the DFC2 portal was used in JWID 02 along with COINs to demonstrate interoperability with Coalition Partners. The JWID portal was administrative in nature and is not currently operational.

Priority Requirement 25 - Implement data extraction and automated assembly mechanisms for automating significant portions of the COCOM's morning brief. [COI-2]

CINC 21 Technology – DFC2, COA Matrix, RFI Manager, Consequence Management, TCCC, Message Tracker

Y Assessment – The CINC 21 Auto Brief technologies were slated to provide these services. The Auto Brief was not developed, and the DFC2 concept was designed to provide output that fulfills many of the briefing functions now comprising the COCOM's morning brief. Implementing mechanisms are not fully developed.

Priority Requirement 26 - Develop automated brief preparation capability based upon content and update of the information/knowledge base. [COI-1]

CINC 21 Technology – DFC2, Consequence Management

Y Assessment – The Consequence Management tool helped users locate, manipulate, and update information needed for briefings. Although it was considered to have very good utility, some improvements to the user interface are needed to improve the tool's usability. The capabilities of DFC2 to support briefings are more limited at this time since it is heavily text-based and the Decision Summary feature has not yet been fully implemented.

Priority Requirement 27 - Develop consequence management and targeted briefing process. [COI-1]

CINC 21 Technology – DFC2, Consequence Management

Assessment – While the Consequence Management tool provided the capability for creating, managing, retrieving, and displaying information used in briefings, no effort was directed toward the business rules, work process, or training necessary to incorporate this tool into USPACOM operations.

Requirement 28 - Develop the standard conference room configuration to allow command/staff organic support (CINC 21-configured conference room).

CINC 21 Technology – DCTS, IWS

Assessment – This requirement was met via the provision of virtual conference rooms that are successfully used in DCTS and IWS.

Requirement 29 - Develop DTDs for OPLANs and CONPLANs. [COI-1]

CINC 21 Technology – Enterprise C2 Infrastructure; Knowledge Core and DFC2: Decision Space Data Schema, Schema Management

Assessment– DTDs were not implemented in the conventional sense. These are web page capabilities to standardize active server pages. CINC 21 focused on the knowledge Core and DFC2 data layer schema. This schema can support the OPLANS and CONPLANS. These schemas are operational on the SIPRNET.

Requirement 30 - Develop the dynamic TPFDD.

CINC 21 Technology – none

Assessment – This requirement was not addressed by CINC 21.

Requirement 31 - Implement mechanisms for automating processes consistent with the workflow management system currently under development at USPACOM. [COI-1]

CINC 21 Technology – Task Management System (TMS)

Assessment – The Task Management System is fully operational at USPACOM. While there are improvements to be made in workflow, it meets current operational requirements.

Requirement 32 - Provide next-generation situation awareness, planning, and force execution tools to the COCOM and integrate with the Knowledge Management environment. [COI-4]

CINC 21 Technology – DFC2, COA Matrix, FBV, AOR Basing

Assessment – While the FBV, AOR Basing, and COA Matrix tools have been developed to provide users with situation awareness and improve planning and force execution tasks as part of the DFC2 concept, they are not currently operationally integrated within the knowledge management environment.

Requirement 33 - Provide the infrastructure that enables selected portions of the COCOM's networks to support prioritized delivery of products and bit-streams.

CINC 21 Technology – none

Assessment – This requirement was not addressed by CINC 21.

Requirement 34 - Field advanced protocols to significantly reduce traffic latency of selected information flows through theater networks.

CINC 21 Technology – none

Assessment – This requirement was not addressed by CINC 21.

Requirement 35 - Develop a creditable solution for auto-generation of security tags for archived data products based upon the current coalition release policy.

CINC 21 Technology – none

Assessment – This requirement was not addressed by CINC 21.

Requirement 36 - Provide high-resolution, large-screen displays to the COCOM that support simultaneous crises and day-to-day operations. [COI-1]

CINC 21 Technology – USPACOM Video Wall, USSTRATCOM Knowledge Wall

G Assessment – The large screen that was provided to USPACOM is fully operational and is used continuously. It affords limited utility in the JOC, however, because of several ergonomic and visibility problems as well as its limited technical capabilities. A different display system, such as that adopted at USSTRATCOM, and an improved workspace layout would substantially enhance the utility of the large screen displays for crisis and routine operations.

Requirement 37 - Develop mechanisms for dynamically managing the pixel real-estate of large displays to improve comprehension. [COI-1]

CINC 21 Technology – USPACOM Video Wall, USSTRATCOM Knowledge Wall

G Assessment – Both large screen displays, at USSTRATCOM and USPACOM are fully operational and used continuously. The USSTRATCOM Knowledge Wall was effective in supporting simultaneous crises and day-to-day operations. However, the USPACOM Video Wall affords limited utility in the JOC because of several ergonomic and visibility problems as well as limited technical abilities.

Requirement 38 - Provide alerting mechanisms that auto-initiate appropriate visualization events. [COI-4]

CINC 21 Technology – DFC2, FBV, TCCC

Assessment – While alerting and adaptive visualization are part of the DFC2 concept, these capabilities were only minimally implemented in the current version of this tool via the status displays of decision points and CCIRs. This capability could be incorporated into FBV and TCCC, but it does not currently exist. This requirement was not sufficiently addressed to allow assessment.

Requirement 39 - Implement homogeneous server–server federations. [COI-4]

CINC 21 Technology – Enterprise C2 Infrastructure; Knowledge Core (XML Data Services) and DFC2 Schema management

Assessment– The Enterprise C2 Infrastructure provides homogeneous server–server federations. It is different in that it does not provide updates to all servers (replication of information) but it provides XML that points to the servers of interest. This capability exists on the SIPRNET, and federations of CUSeeMe® conference servers were employed in KB(X).

Requirement 40 - Develop the standard mobile client workstation configuration and software to allow command/staff organic support (CINC 21-configured mobile workstation).

CINC 21 Technology – none

Assessment – This requirement was not addressed by CINC 21.

Requirement 41 - Provide high-resolution, large displays to a JTF capable of supporting simultaneous crisis operations. [COI-4]

CINC 21 Technology – USSTRATCOM Knowledge Wall, PV290

Assessment – This requirement was addressed during KB(X). The USSTRATCOM Knowledge Wall provided a high-resolution large screen to the I MEF JTF to support simultaneous crisis operations in coordination with a COCOM.

Requirement 42 - Provide a method for accessing knowledge objects across security enclaves with minimal latency.

CINC 21 Technology – none

Assessment – This requirement was not addressed by CINC 21.

Requirement 43 - Prepare for the transition from Ipv4 to Ipv6 by performing selected experimentation and risk reduction activities on selected theater networks.

CINC 21 Technology – none

Assessment – This requirement was not addressed by CINC 21.

Requirement 44 - Provide multi-modal human–computer interface capabilities (e.g., voice, head-tracking, gesture, hand-pointing).

CINC 21 Technology – none

Assessment – This requirement was not addressed by CINC 21.

So What?

The previous sections have summarized the findings from many of the CINC 21 products, assessment events, and requirements. Much detail has been provided, and even more specifics are provided in the individual product assessment reports (see Appendices). Yet, it is often difficult to see general patterns concerning military utility and transition potential from detailed results. Therefore, this section combines these data to support general conclusions about the CINC 21 products.

Summary ratings of the products, organized by technology categories, are presented first. The extent to which the prioritized requirements have been satisfied for each COI is then provided. The findings have been aggregated for the CINC 21 COIs. Finally, transition of CINC 21 products is discussed.

Technology Categories

Table 12 summarizes the composite ratings for Suitability, Usability, and Technical for each CINC 21 technology category. The CINC 21 Operational Manager and Development Manager had identified the products that related to each of the COIs. These mappings were used to associate the technology categories with the COIs. In cases where a technology category applies to more than one COI, different aspects were evaluated. For example, DFC2 involves the presentation of information (COI-1) and the organization and management of that information in a common knowledge core (COI-2).

Ratings were assigned to the individual technologies in the Special Projects category; however, these technologies are not slated for further development or for transition. Therefore, ratings of these individual technologies are not combined to a technology category composite score.

Decision-Focused Command and Control

The *concept* of DFC2—integrated applications that facilitate the definition, visualization, analysis, and management of decision-making activities associated with joint command and control—was well-received by users. However, there is currently a lack of functioning links between component parts and between decision objects within component parts. The document linking and management services in their current stage of development do not fulfill users' needs. In addition, concerns regarding the impact of DFC2 upon workload and organizational procedures remain.

Table 12. Technology category composite ratings for Suitability (S), Usability (U), and Technical (T) assessment criteria in terms of Critical Operational Issues (COI).

Technology Category	COI-1			COI-2			COI-3			COI-4		
	S	U	T	S	U	T	S	U	T	S	U	T
Decision-Focused C2 [details]	Y	Y	Y	Y	Y	Y	NA	NA	NA	NA	NA	NA
Ops Package: COP / Geo-Spatial Visualization [details]	G	G	Y	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ops Package: Briefing / Information Summary [details]	G	G	G	G	G	Y	NA	NA	NA	NA	NA	NA
Ops Package: Status Tracking and Linking [details]	G	Y	G	Y	Y	Y	NA	NA	NA	NA	NA	NA
Ops Package: Time-based Event Management [details]	G	G	G	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ops Package: JWID Coalition Interoperability Service (COINS) [details]	NA	NA	NA	G	Y	G	NA	NA	NA	NA	NA	NA
Displays: Group Displays [details]	G	G	G	NA	NA	NA	NA	NA	NA	NA	NA	NA
Displays: Workstation Displays [details]	G	G	G	NA	NA	NA	NA	NA	NA	NA	NA	NA
Collaboration [details]	NA	NA	NA	NA	NA	NA	G	Y	Y	NA	NA	NA
Network Operations Tools and Services [details]	NA	NA	NA	NA	NA	NA	NA	NA	NA	G	Y	Y

For COI-1, Suitability was rated as YELLOW due to the concerns expressed above and various layout problems that impeded decision-focused visualization. Specifically, some of the web parts were located completely off the screen, requiring users to scroll horizontally and vertically to access this information. Unfortunately, even if users did know that this off-screen information existed, they would have great difficulty in noticing changes or in using it to provide integrated situation awareness. Redesign of the screen layout is needed so that users can simultaneously view all the important DFC2 information without scrolling. What information is considered important is likely to differ across users, and in some cases, multi-screen workstations will be necessary to meet their task needs.

Suitability was also rated as YELLOW for COI-2. The inflexibility of the schema in the current version of DFC2 was troublesome for users, who work in a highly dynamic information environment. The procedural adaptations necessary to match the operational information and situations to the DFC2 schema were considered cumbersome.

Usability problems were experienced throughout the assessment events, especially in areas of configuration retention and navigation. Much of the detail is presented as text and tables, which inhibits rapid understanding and visualization of the information. Excessive scrollbars limit users' ability to maneuver, and they present a confusing display. Many functions require numerous steps as well as interaction with multiple dialog boxes. Also, the use of screen real estate is less than optimal; web parts are located partially or completely off the screen. As a result of these problems, Usability was rated as YELLOW for COI-1 and COI-2.

A slow refresh rate and some instability of component parts occurred throughout the assessment events. These problems interfered with users as they attempted to input or access information. There were intermittent crashes of DFC2 during TF03; these crashes were associated with data losses. Thus, the Technical rating was YELLOW for COI-1. The Technical rating for COI-2 was also YELLOW. The lack of linking between web parts seriously inhibited the users' ability to access and edit data between views.

Operational Packages

Common Operational Picture/Geo-Spatial Visualization

AORB and the FBV earned a GREEN rating in Suitability, as users reported that both would help them achieve their operational goals. They appreciated the concept of the geo-spatial representation, in which they could drill down and gather their desired content. During the time of assessment, AORB was in an early stage of development and the databases needed to support its capability were not available. The Technical category, therefore, received a YELLOW rating. Although not as serious an issue, FBV was also rated as YELLOW on Technical because it did not yet include information classified secret, which users said was needed to be of real value. Both technologies rated a GREEN in Usability because users were able to successfully navigate the tools and reach their desired information. Along the way, however, there were problems encountered in workflow, highlighting a need for future usability assistance.

Briefing/Information Summary

The COA Matrix and Consequence Management tools appear to meet their operational requirements. Operational staff and decision-makers found these products to be useful in providing a rapid way to visualize the situation and in managing the underlying information consistently. As a result, Suitability was rated as GREEN for COI-1 and COI-2.

The COA Matrix was assessed as GREEN on Usability, while Consequence Management was rated as YELLOW. Since the usability of the COA Matrix was so well received by its audience, the overall summary assessment of Usability was rated as GREEN for COI-1 and COI-2. The usability problems with Consequence Management, principally concerning information presentation and visualization, should be addressed before further development.

For COI-1, the briefing and information summary products were rated as GREEN, since they operated reliably and effectively in presenting information to users. While these products seemed to manage the underlying data accurately and effectively, the Technical rating for COI-2 was YELLOW because of security issues. To become more useful in operational settings, these products will need to give access to multi-level security materials.

Status Tracking and Linking

For this technology category, Suitability for COI-1 is GREEN. The Message Tracker, RFI manager, and TeamApp all allow the user to visualize complex information in a form that is relevant to their tasking. The Suitability rating for COI-2 is YELLOW. User management issues are of concern. The "fit" of Message Tracker and RFI manager into the users' work processes is questionable, as was the level of user acceptance of these technologies to help them manager their messages and information requests.

Usability for COI-1 is YELLOW. Colors and formatting that do not meet human–computer interface standards negatively affect user navigation and readability. For COI-2, TeamApp is easy to use and its interface features support the intended functions. However, training requirements and memory and workload demands are excessive for Message Tracker and RFI Manager. The combined rating is YELLOW.

Technical for COI-1 is GREEN. Operations of these technologies were reliable in presenting their information to users. COI-2 is YELLOW, as refresh and download rates may be too slow for operational use.

Time-Based Event Management

While there is room for improvement in addressing the needs of individual users, the Master Calendar and the TMS generally meet the needs of their users. They have been accepted by the users and are currently used at USPACOM. Therefore, Suitability is assessed as GREEN. Usability was rated as GREEN since the products were considered easy to use. Both products are currently in use and function reliably, so the Technical rating was GREEN.

JWID Coalition Interoperability Service (COINS)

Suitability for the JWID Coalition Interoperability Service (COINS) component is GREEN. COINS provides capabilities of value for integrating information, context, and rules to increase

understanding and improve decision-making. Usability for JWID COINS component is YELLOW. The search process required much duplication of effort, and the format for display of results was not well-designed. The inability to seamlessly transfer data to other applications was also associated with duplication of effort. Technical issues are rated GREEN. Availability of the technology and accessibility to the data was adequate.

Displays

Group Displays

The USSTRATCOM Knowledge Wall and the USPACOM Video Wall earned GREEN scores across the board. Both walls are currently in use, accounting for a GREEN in the Technical category. Both earned a GREEN in Suitability. The USSTRATCOM Knowledge Wall effectively met the needs of the senior decision-makers during the October demonstration. It also is rated well (GREEN) on Usability. The Knowledge Wall operators were able to manipulate content and present in a way that was relevant and legible. However, there are currently some unresolved issues regarding the Video Wall with respect to Usability, Suitability, and Technical that may require further study. The success of the USSTRATCOM Knowledge Wall, though, outweighs any inadequacies found on the USPACOM Video Wall.

Workstation Displays

This technology category received a score of GREEN in Suitability, Usability, and Technical. The multiple, side-by-side flat panel monitors represent a completely workable solution that can compensate for the drawbacks of the PV290.

The PV290 was used during the USSTRATCOM October event. It was well-received by users and performed without incident. During TF03, at USPACOM, users reported their three flat-panel display workstation was essential in providing users a continuous view of the various web parts. This view increased the usability of the displays and helped meet their operational requirements. However, they found the workstation to be only effective in presenting content to the user sitting directly in front of the screens, and not to others standing around the display. There were also numerous complaints that the font was too small.

Collaboration

Distributed users found high value in sharing documents, briefs, and desktops. They considered that collaboration tools provide an efficient mechanism for the exchange of information. Users judged that collaborative sessions led to increased situation awareness. Suitability is rated GREEN.

However, chat often became the de facto collaboration tool due to bandwidth restrictions. Audio was preferred when available; video was often unstable and considered by many users to be redundant and unnecessary. The status of audio–video and of session membership was frequently difficult to discern with the DCTS technologies. Feedback to the user regarding success of data transmittals was not always adequate. In addition, several areas of the IWS computer interface were identified as requiring modification to improve ease of use. Other impediments to use are lack of training, lack of business rules, and lack of interoperability between collaboration systems. Usability is rated YELLOW.

The inability of DCTS technologies to provide stable connectivity is an obstacle toward reaching the goal of synchronizing decision-making and information management among distributed users. In addition to the technical aspects, personnel's confidence and willingness to use these collaboration tools is negatively impacted. However, the ability to provide stable connectivity was demonstrated with IWS in actual operational use. Therefore, the Technical rating for the CINC 21 collaborative services technology category is YELLOW.

Network Operations Tools and Services

Many Network Operations Tools and Services were implemented. The users valued the assets, finding the information current and precise. These tools give the network managers the ability to interact with other management tools, thus providing the users with a needed capability. The portal approach resulted in flexibility of display and screen space usage and external access to NetOps generated data. Suitability is rated GREEN.

The users found the Theater C4ISR Status Grid useful for such tasks as changing layout and exchanging information. However, the workload was not decreased and the learning curve was difficult. Usability is rated YELLOW.

Transmitted information did not increase ability to view and monitor network operations. There were problems with the implementation and integration of Status Monitoring. The EICS data visualization needs improvement for easier comprehension. Link analysis visualization requires additional filtering capability. The Technical rating is YELLOW.

While the JMUA was limited to the data collected at that time, all of the NetOps tools are scheduled for transition to DFC2, which will be implemented in the DISA Network-Centric Enterprise Services (NCES)/Joint Command and Control (JC2) efforts.

The NetOps Network Status Monitoring will transition to the USPACOM TCCC. The AIDE visualizations (EICS, EPC, and Link Analysis) will transition to the DISA Information Superiority Situational Awareness (ISSA) Portal initiative.

Prioritized Requirements

Table 13 summarizes how well CINC 21 products met the prioritized requirements. The CINC 21 Operational Manager and Development Manager identified which requirements supported each COI, and the table reflects that mapping. A few of the requirements did not match any of the COIs (10, 28, 30, 33, 34, 35, 40, 42, 43, 44). Some of the requirements that did relate to a COI were not sufficiently addressed by CINC 21 products to permit assessment.

For COI-1, 9 of the 13 requirements were in the top 27 priority items. Most of these requirements were assessed as partially met. Standard hardware and software configurations have been installed at USPACOM and STRACOM and are operating effectively (Requirements 1, 36, 37). CINC 21 has also successfully developed software to maintain situation awareness by

accessing data, by viewing briefings, and by managing workflow (Requirements 4, 5, 23, 31). Domain-independent mechanisms for tailoring the presentation and for displaying information linkages have been partially implemented by DFC2 and other products, but expanded capabilities are needed (Requirements 2, 3). Good initial efforts were made to access support services and to automate the preparation of briefing materials, but substantial additional work will be needed to provide an operational product (Requirements 24, 26, 27, 29).

All four of the requirements for COI-2 were in the priority set of 27. Mechanisms for the theater-wide access to information and published products were successfully developed (Requirements 20, 22). Initial efforts to organize information around user-defined themes were provided by DFC2, but additional development is needed to support cross-echelon knowledge exchange (Requirement 21). The data extraction and automated mechanisms to support preparation of regular briefings and reports have been demonstrated, but further work is required to implement these capabilities fully (Requirement 25).

Of the 10 requirements for COI-3, 9 were in the top 27 priority set. DCTS and IWS provided virtual conference rooms to promote collaboration (Requirement 28). DCTS was able to operate on unclassified and classified networks to connect distributed teams, but the quality and reliability of the connections was poor—limiting the utility of these collaborative sessions (Requirements 6, 11, 13, 14, 15, 19). DFC2 provides the framework for a thematic collaborative system, but a greater degree of user aiding/automation is needed to implement this requirement fully (Requirement 7). The capability to automatically establish and manage collaborative sessions based on workflow and operational priorities has been partially implemented in DFC2, and further enhancements of this capability are planned (Requirement 17).

Four of the eight requirements for COI-4 were among the 27 priority items. VPN capabilities were successfully implemented to enable collaborative tools to operate in the presence of firewalls and to connect allied commanders (Requirements 12, 18, 39, 41). Several tools have been developed that support situation awareness, planning, and execution monitoring, but these products need to be integrated more fully with the knowledge management environment (Requirements 9, 32).

Note that the requirements, as stated, primarily concern technical issues rather than suitability or usability issues. For the most part, they presume that improved operational workflow and decision-making will result from the presence of these technical capabilities.

Table 13. Ratings for CINC 21 products in terms of prioritized requirements and COI.

COI-1 [details]		COI-2 [details]		COI-3 [details]		COI-4 [details]	
Priority Reqmt	Assessment Rating	Priority Reqmt	Assessment Rating	Priority Reqmt	Assessment Rating	Priority Reqmt	Assessment Rating
1	G	20	G	6	Y	8	B&W
2	Y	21	Y	7	Y	9	Y
3	Y	22	G	11	Y	12	G
4	Y	25	Y	13	Y	18	G
5	G			14	Y	32	Y
23	G			15	Y	38	B&W
24	Y			16	B&W	39	G
26	Y			17	Y	41	G
27	Y			19	Y		
29	Y			28	G		
31	G						
36	G						
37	G						

Note: G GREEN = requirement met,
Y YELLOW = requirement partially met,
R RED = major obstacle prevents requirement from being met,
B&W = requirement not addressed.

Critical Operational Issues

It is useful to aggregate across the CINC 21 products and technology categories to provide an overall assessment of how well the COIs were met. To do this, it was necessary to determine weights for how much the technology categories support each COI. A consensus among six members of the CINC 21 assessment team produced the following weights. The group determined that differential weights were appropriate, since some of the technology categories were more central to the core concepts of CINC 21 and the COIs. A four-point ordinal scale was adopted to define the category weights. As it becomes possible to incorporate input from the CINC 21 Operational Manager, Technical Manager, Development Manager, Implementation Manager, and Transition Manager, these weights may be adjusted to reflect the broader consensus.

- Very Significant (weight = 4) .....Decision-Focused Command and Control
- Significant Element (weight = 3).....Ops Package: COP/Geo-Spatial Visualization
  Ops Package: Briefing/Information Summary
  Ops Package: JWID COINS
  Collaboration
  Network Operations Tools and Services
- Important Element (weight = 2).....Ops Package: Status Tracking and Linking
- Contributing Element (weight = 1).....Ops Package: Time-based Event Management
  Displays: Group Displays
  Displays: Workstation Displays

The overall assessments of Suitability, Usability, and Technical for each COI are shown in Table 14. The CINC 21 products that contribute to COI-1 were generally considered to help decision-makers and staff to process, digest, and assimilate large amounts of complex information. Most of these products were useful for the operational tasks and work processes, and they were relatively easy to use. Certainly, several enhancements can be made to further these products, and these refinements can be made during the technology transition phase. Suitability and Usability are rated as GREEN for the combination of products related to COI-1. The overall rating for COI-1 for Technical is YELLOW because many of the products were not yet developed to the point where they could reliably provide dynamic, real-world data to users.

Overall, the Suitability and Usability COI-1 objectives are being met, but there are concerns with the DFC2 that should be addressed. There are still issues to be resolved regarding how best to integrate all the relevant information and present it in a useful manner.

The CINC 21 products and concepts provided many exciting and innovative approaches to knowledge management. Technologies that help integrate information, context, and rules will certainly increase situation understanding and improve decision-making. The idea of providing a framework for linking and integrating information is an excellent step towards meeting the users' operational requirements. The current versions of the products, however, need further refinement

to achieve these goals to the levels needed by operational users. For COI-2, Suitability, Usability, and Technical ratings were all YELLOW. Suitability can be improved by linking more of the key data sources together. Usability can be improved by making it easier for operational users to ingest and link messages and other data together. As discussed above, many technical challenges remain to be resolved concerning how to enable CINC 21 products to deliver the range of operational content that users need in an accurate and reliable manner.

Table 14. Overall assessments of Suitability, Usability, and Technical for each COI.

Critical Operational Issue	Suitability	Usability	Technical
1 – Decision-Focused Visualization	G	G	Y
2 – Knowledge Management	Y	Y	Y
3 – Collaboration	G	Y	Y
4 – Enterprise Awareness & Network Security	G	Y	Y

As called for in COI-3, collaboration technology is an important capability that can enhance distributed decision-making substantially. Users consistently reinforced this, reporting that the CINC 21 collaboration products were very useful for their operational needs. Suitability, was, therefore, rated as GREEN. Some of the collaboration products were difficult to configure and to use, however. This difficulty accounts for the YELLOW rating for Usability. The biggest obstacle for collaboration technology was clearly the Technical issues; this area was also rated as YELLOW. The products were often incompatible with each other, required excessive bandwidth, and operated unreliably. If these technical issues can be overcome, then collaboration technology would add an important capability.

COI-4 calls for advances in the secure exchange of information across multiple, distributed networks, databases, and applications. The CINC 21 products developed to satisfy COI-4 include Theater C4ISR Status Grid and Network Operations Status Monitoring Tools. Security via VPN (as part of the Special Projects) was enabled and provided secure collaboration capabilities. Network tools allowed ready access to data across the coalition network. Given these successes, as well as the homogenous server–server federations and flexibility, the Network Operations tool suite will be featured in next-generation implementations. Suitability for COI-4 was rated as GREEN. There were some operational and integration issues, however, with information assurance tools that impede achievement of all requirements. Ratings for Usability and Technical were YELLOW.

Transition Recommendations

Many varied types of technical products were developed as part of the CINC 21 program. While some applications directly support users' work processes and tasks, others involve system architecture concepts and enterprise infrastructure that enable other products to function effectively. Some products explore the feasibility of potentially relevant techniques, and other interim products were abandoned as the focus changed due to external factors, like NMCI.

As a result, transition recommendations are somewhat difficult to provide for all CINC 21 products. Our approach focuses on products that operational decision-makers and staff would use directly. The underlying concepts and infrastructure that enable users to use these products are incorporated implicitly. Interim products and special projects are not considered.

CINC 21 Products for Transition

The set of CINC 21 products that are candidates for transition according to this approach were identified. The Suitability, Usability, and Technical assessment for these products were reviewed to determine which products are mature enough for transition and have adequate potential to provide military utility. These transition products are listed below in Table 15 along with their summary ratings for Suitability, Usability, and Technical. Specific enhancements are recommended that are intended to help these products achieve an acceptable level of performance in an operational setting. These recommendations are presented in more detail following the table.

The order in which the products appear in Table 15 reflects the Operational Manager's priorities, which were largely determined by the amount of effort estimated to be required to make the recommended enhancements. Thus, products toward the top of the list are anticipated to reach transition sooner than those toward the bottom.

TeamApp

This web-based product helps users organize information that is considered pertinent to an event. It was found to be useful for transferring files, sharing briefings, responding to CCIRs, and exchanging information. Users considered TeamApp easy to use, and they used it for various purposes. Improved system response time for downloads would be a significant enhancement, however.

- Reduce the download time, particularly under limited bandwidth conditions.

Table 15. CINC 21 products recommended for transition

CINC 21 Product	Suitability	Usability	Technical	Recommended Enhancements
TeamApp [details]	G	G	Y	• Reduce download times
Task Management System [details]	Y	G	G	• Provide user training and notification • Show task dependencies
Master Calendar [details]	G	G	G	• Add flexible calendar configurations
Fused Battlespace View [details]	G	G	Y	• Allow info exchange across security levels
RFI Manager [details]	Y	Y	G	• Integrate COCOM and JTF processes • Improve the user interface • Allow custom displays • Provide user training and on-line help
Network Operations Tools and Services [details]	G	Y	Y	• Integrate with work processes • Reduce the number of task steps needed to operate • Integrate with current systems
Visualization (Displays) [details]	G	G	G	• Determine layout of information on multi-screen workspaces
Message Tracker [details]	G	Y	G	• Integrate with other tools • Improve the user interface • Provide user training and on-line help
DFC2 [details]	Y	Y	Y	• Develop expanded capabilities • Simplify / automate message ingestion • Improve the user interface • Provide user training and on-line help
Collaboration [details]	G	Y	Y	• Provide user training and business rules • Provide interoperability • Improve system reliability

Task Management System

This product provides a web-based structure for tracking events and tasks across offices and echelons. The system has been in operational use for some time without incident, and the latest version has good usability. The only significant limitations with this product concerns who is using the system and how they are using it. User training and standard operating procedures would be helpful here.

- Provide training and standard operating procedures so that all users use the system in a similar manner and for similar purposes.
- Develop a task notification procedure/technology to supplement e-mail, since personnel currently need to be at their computer to receive tasking.
- Provide a way to show task dependencies and conflicts.

Master Calendar

This product is a web-based tool that presents time-based events in a calendar format. It provides several different views, enabling users to detect conflicts and overlaps. It was very useful and easy to use. It has been operating effectively at USPACOM for some time. Only minor enhancements were recommended.

- Add more options for customizing the display to allow flexible calendar configurations.

Fused Battlespace View

This product was developed to access and manipulate information relevant for USSTRATCOM. It provides a geo-spatial context with drill-down capability within USSTRATCOM operational process. Users found it very useful, reducing the time and personnel involved in retrieving information. Users found it easy to use, but they needed access to multi-level security information

- Provide access to unclassified and classified information.
- Expand the drill-down capability to include additional levels.
- Improve some aspects of the user interface, including font size, link colors, etc.

RFI Manager

RFI Manager is a stand-alone product tracks requests for information, due dates, completion status, and responsible office/person. It has been used extensively in the JTF environment, but RFI Manager has not yet been fully integrated with USPACOM systems. While the RFI Manager is a useful tool, particularly at JTFs, it needs to be integrated with other systems, and its user interface needs various upgrades.

- Integrate RFI Manager with COCOM and JTF processes and databases.
- Conduct a job/workflow analysis to incorporate RFI Manager into COCOM and JTF message management processes without increasing workload.
- Improve the user interface in several ways, including navigation aids, feedback, error checking, alerting, screen layout, RFI status summary, etc.

- Provide the capability for users to customize their displays.
- Provide user training, documentation, and online help.
- Increase refresh rate to a level appropriate for operational use.

Network Operations Tools and Services

This product currently represents a suite of tools intended to help users view the operational status of networks in the theater. These tools were generally considered useful for presenting important status information for theater networks and information assurance. The visualizations were well-suited for TCCC users but were less directly useful for other potential users, such as those in the JOC. Several enhancements in the usability and technical aspects of these tools are recommended.

- Revise the Theater C4ISR Status Grid display to provide information in a form that is more closely integrated with TCCC and JOC work processes.
- Reduce the number of task steps needed to operate the Theater C4ISR Status Grid, and simplify the user interface to make it easier to learn and use.
- Reformat the information presented in the EICS and link analysis tools to improve user comprehension of the data and to reduce display complexity/clutter.
- Implement these tools in an operational environment (e.g., USPACOM) to demonstrate reliable access, rapid system response time, and accurate data transfer with current systems.

Visualization (Displays)

Several display products were examined to provide improved visualization of complex data sets. Displays included large screens designed for group viewing, as well as multi-screen workstations for individual users. While some products were found to be unsuitable for COCOM and JTF usage, others met the operational needs quite well. These display technologies were considered to be useful, easy to use, and stable. Careful consideration of the layout of information to be displayed on these devices is needed, however.

- Develop default settings that allow the displayed information to be properly scaled, sized, and configured to support the expected number of viewers (e.g., large group, small team, individual) under work area and lighting constraints.
- Develop guidelines for the effective layout of information onto the available screen space. Provide user training to encourage display customization.

Message Tracker

This product allows users to read messages and link them to operations or to CCIRs. It has various capabilities for capturing, filtering, grouping, archiving, and organizing messages. It was found to be effective at linking messages to significant events and increasing staff access to relevant information. Several usability enhancements are recommended, but the Message Tracker has been functioning effectively in the USPACOM environment.

- Integrate Message Tracker with current tools and work processes.
- Improve the user interface in several ways, including navigation aids, background colors, feedback, error checking, alerting, and display customization.
- Provide user training, documentation, and online help.
- Increase the refresh rate to a level appropriate for operational use.

Decision-Focused Command Control (DFC2)

This is the main product of the CINC 21 effort. DFC2 is a set of software components that facilitate an array of information management functions. It is implemented as a presentation layer, business layer, and data layer. Users considered the DFC2 concept to be valuable for managing large, complex data sets and for maintaining situation awareness of multiple events. The current implementation of DFC2, however, needs substantially greater functionality to become suitable for operational use. Similarly, several usability and technical problems need to be overcome before DFC2 can achieve military utility.

- Provide pedigree information about objects and information elements, including state changes, user comments, alerts, context changes, and links to other tasks.
- Integrate collaboration tools with objects and information elements. This integration includes capabilities for text chat, shared data, task linking, and shared audio/video.
- Provide an easy-to-use capability for alerting users based on context-sensitive and position-sensitive rules and conditions.
- Develop labels and schema that match COCOM processes and terms.
- Enable persistence of data displays for individual users.
- Provide error checking support, date–time conversion, and automatic backup.
- Enable messages to be parsed and ingested into the system automatically.
- Implement the capability to link messages and other information products to other objects, processes, collaboration workspaces, CCIRs, etc.
- Develop easy-to-use rules for status thresholds and for displaying status information.
- Provide capabilities for searching, filtering, and organizing messages, documents, and other information.
- Improve the user interface in numerous ways, including layout of information on screens, font size, text wrap, scrolling, highlights, colors, icons, consistency, etc.
- Improve data visualization, particularly for decision summaries, by enabling data to be shown in various forms (tabular, geo-spatial, temporal, etc.).
- Enable the user to associate information objects via drag-and-drop.

- Provide the capability for personalization/customization of user information displays within the framework of predefined defaults and templates.
- Develop substantially expanded capabilities for creating, editing, deleting, importing, linking, and manipulating objects and information elements.
- Provide the capability to navigate through the decision space hierarchically, temporally, and geo-spatially depending on the situation and user needs.
- Develop capabilities for assigning, tracking, and managing tasks within an integrated DFC2 framework.
- Provide user training, documentation, on-line aids, and templates.
- Assure reliable system operation under distributed operations with multiple concurrent users.

Collaboration

The general capability for collaboration relies on several tools, including DCTS and IWS. Users considered collaboration tools to be highly useful, promoting shared situation awareness. Various usability issues and operating procedures should be addressed to improve information exchange among multiple concurrent users. The most substantial shortcoming, however, concerns the unstable connectivity, limited interoperability among different collaboration systems, and high bandwidth consumption.

- Improve the feedback provided to users concerning login, active/available sessions, active participants, data transfers, and status of audio/video channels.
- Provide training, business rules, or standard operating procedures for efficient use of collaboration tools and sessions.
- Provide stable connectivity among an operationally relevant number of concurrent users on the full range of collaboration tools.
- Provide reliable interoperability among different collaboration systems.

Several CINC 21 products were identified as not ready for transition. These products are listed below. Some of these products were developed only as interim products to test the feasibility of a particular solution, while others were not pursued for various technical reasons.

- Area of Responsibility Basing
- Consequence Management Automated Brief
- Course of Action Matrix
- JWID COINS
- USPACOM Video Wall
- PV290 Multi-Screen Desktop Display
- BMC Patrol
- USSTRATCOM Portal
- JWID Administrative Portal
- Quality of Service

- Virtual Private Network
- 3Com® Embedded Firewall NIC Cards
- Other Special Projects (IPv6, NETIQ, NET VCR, MRTG)

Extended User Evaluation

To move forward to an effective transition of CINC 21 products, several important steps are recommended. Together, these steps are part of the Extended User Evaluation (EUE).

The CINC 21 products that have been identified for transition need to be incorporated into a feasible standard operating procedure (SOP) that includes defined staff roles and work processes. While substantial variations in the details of the SOP are expected across COCOMs because of their unique responsibilities and operating areas, there should be a common framework. The CINC 21 operating concepts and system architecture enable the products to be used in a common manner that generalizes to many different environments, including COCOMs and JTFs.

Various enhancements will need to be made to the CINC 21 products to make them more suitable, usable, and technically sound in operational settings. Several specific suggestions for these enhancements have been provided for CINC 21 products in this report and in previous assessment reports (see Appendices). Operational users should have periodic opportunities to review the technical modifications and to provide feedback on the enhancements.

Once the product enhancements have been made and reviewed by representative operational users, a variety of supporting documentation will need to be prepared. This documentation includes training materials, system support and administration procedures, and similar reference materials.

Finally, the enhanced product capabilities should be assessed in a realistic operational context. This assessment is not focused on determining military utility but rather on verifying that the product enhancements function properly and do indeed satisfy user needs and system requirements.

Appendix A. Listing of Assessment Reports

Appendix	Report/Document	JMUA Report Section	Applicable to…
A	Listing of Assessment Reports		
B	Smillie, R.J. & Griffin, R.N. (May 02). *CINC 21 Military Utility Assessment Plan: FY 02-03.* San Diego: Space & Naval Warfare Systems Center..	How Was CINC 21 Assessed?	Assessment Plan
C	Heacox, N. (Feb 03). *CINC 21 Technologies: Final Status of Data Collected.* San Diego: Pacific Science & Engineering Group, Inc.	Outcome	Military Effectiveness Criteria Summary
D	Heacox, N. J. (Jan 2003). *An assessment of CINC 21 technology: The decision-focused command and control (DFC2) interface: Initial decision space management features.* San Diego: Pacific Science & Engineering Group, Inc.	Outcome	DFC2: Dec. Space Mgt
E	Heacox, N. J. (Jan 2003). *An assessment of CINC 21 technology: The decision-focused command and control (DFC2) interface: Status, collaboration, net ops, decision summary and battle rhythm features.* San Diego: Pacific Science & Engineering Group, Inc.	Outcome	DFC2: Dec. Space Mgt. Dec. Summary Chat Battle Rhythm Status Rule Management Infrastructure and Security
F	Heacox, N. J. (Jan 2003). *An assessment of CINC 21 technology: The decision-focused command and control (DFC2) interface: Shadow play at the Terminal Fury '03 (TF03) exercise.* San Diego: Pacific Science & Engineering Group, Inc.	Outcome	DFC2: Dec. Space Mgt. Dec. Summary Chat Battle Rhythm Status Rule Management Infrastructure and Security
G	Smillie, R. (Dec 2002). *DFC2UsabilityIssues*. San Diego: Space and Naval Warfare Systems Center.	Outcome	DFC2: Dec. Space Mgt
H	Mitchell, C. (Apr 2002*). Assessment of the User Interface and Functional Utility of the CINC 21 Area Of Responsibility Basing System*. San Diego: Pacific Science & Engineering Group, Inc.	Outcome	AORB
I	Sander, S., Smillie, R.J., & Mitchell, C. (Oct 2002). *USSTRATCOM/CINC 21 Consequence Management/Response Demonstration: Assessment Report*. San Diego: Space and Naval Warfare Systems Center.	Outcome	FBV COA matrix USSTRATCOM Portal Collaboration

Appendix	Report/Document	JMUA Report Section	Applicable to…
J	Henry, C. (May 2002). *Review of the Human - Computer Interface for Consequence Management*. San Diego: Pacific Science & Engineering Group, Inc	Outcome	Consequence Management
K	Henry, C. (Jul 2002). *A Limited Assessment of the Human - Computer Interface and Usability of the Consequence Management System.* San Diego: Pacific Science & Engineering Group, Inc	Outcome	Consequence Management
L	Henry, C. (May 2002). *Review of the Human - Computer Interface for Order Tracker*. San Diego: Pacific Science & Engineering Group, Inc	Outcome	Message Tracker
M	Heacox, N. (Oct 2002). *A Limited Assessment of CINC 21 Technology: The Message Tracker.* San Diego: Pacific Science & Engineering Group, Inc	Outcome	Message Tracker
N	Henry, C. (Jul 2002). *A Limited Assessment of the Human - Computer Interface and Usability of the Order Tracker System.* San Diego: Pacific Science & Engineering Group, Inc	Outcome	Message Tracker
O	Heacox, N. (Oct 2002). *A Limited Assessment of CINC 21 Technology: The Request for Information Manager.* San Diego: Pacific Science & Engineering Group, Inc	Outcome	RFI Manager
P	Henry, C. (Jul 2002). *A Limited Assessment of the Human - Computer Interface and Usability of the Request for Information Manager.* San Diego: Pacific Science & Engineering Group, Inc	Outcome	RFI Manager
R	CINC 21 Human Systems Integration Team (Oct 2001). *Commander in Chief 21st Century (CINC 21) Advanced Concept Technology Demonstration (ACTD): Assessment during Kernel Blitz Experimental (KB(X)): Final Report.* San Diego: Pacific Science & Engineering Group, Inc	Outcome	TeamApp
S	Mitchell, C. (Dec 2002). *Task Management System: User Feedback and Heuristic Evaluation*. San Diego: Pacific Science & Engineering Group, Inc	Outcome	Task Management System (TMS)
T	Mitchell, C. (Dec 2002). *Master Calendar: User Feedback and Heuristic Evaluation*. San Diego: Pacific Science & Engineering Group, Inc	Outcome	Master Calendar

Appendix	Report/Document	JMUA Report Section	Applicable to…
U	Heacox, N., Pester-DeWan, J., & Obermayer, R. (Jul 2002). *Commander in Chief 21st Century (CINC 21) Advanced Concept Technology Demonstration (ACTD): Military Utility Assessment During Joint Warfighter Interoperability Demonstration (JWID) 2002: Final Report.* San Diego: Pacific Science & Engineering Group, Inc	Outcome	JWID Admin Portal JWID COINs Collaboration Infrastructure and Security
V	CINC 21 Human Systems Integration Team (Nov 2000). *Commander in Chief 21st century (CINC 21) Advanced Concept Technology Demonstration (ACTD:) Build 1Technologies Assessment Report.* San Diego: Pacific Science & Engineering Group, Inc.	Outcome	Collaboration Infrastructure and Security
W	Pester-DeWan, J., & Heacox, N.J. (May 2002). *Assessment of Supportability And Usability of NetMeeting in a Distributed Environment.* San Diego: Pacific Science & Engineering Group, Inc.	Outcome	Collaboration
X	Mitchell, C. (Oct 2002). *STRATCOM Knowledge Wall Lessons Learned and Legibility LAO*. San Diego: Pacific Science & Engineering Group, Inc	Outcome	USSTRATCOM Knowledge Wall
Y	Obermayer, R. (May 2002). *Human Factors Critique Of The JWID Portal.* San Diego: Pacific Science & Engineering Group, Inc	Outcome	JWID Admin Portal
Z	Joint Information Operations Center Technology Evaluation Branch. (April 21, 2002). *Microsoft® Remote Routing and Access Server/Alcatel® Gateway Virtual Private Network (VPN) vs. Cisco® VPN Concentrator/Microsoft® Internet Authentication Service, Remote Access Dial-In Service.* Washington, D.C.: Author.	Outcome	Network Operations Tools and Services

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14. ABSTRACT

The Commander in Chief 21st Century (CINC 21) is an Advanced Concept Technology Demonstration (ACTD) that was designed to provide broad solutions to these problems. CINC 21's goal was designed to provide broad solutions to these problems. CINC 21's goal is to improve command and control of forces by exploiting advanced visualization techniques and decision support systems (e.g., presentations, cueing, triggers, alerts), collaboration capabilities, and knowledge and enterprise management technologies. CINC 21 used information technology to reduce dependence on centralized, single-crisis command centers in favor of decentralized, rapidly configured coalition and interagency enclaves. To evaluate the technologies developed as part of the CINC 21 ACTD, a Joint Military Utility Assessment (JMUA) was planned and executed. The purpose of the JMUA was to determine how well the CINC 21 products met warfighter requirements. The general approach for the JMUA involved several phases—some analytic and others empirical. In this way, the most complete technology assessment would be conducted in an efficient manner that is minimally intrusive on any exercises or other events in which CINC 21 was being demonstrated/evaluated.

15. SUBJECT TERMS

Mission Area: Command and Control

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